I. Setting the stage

Aparna Keshaviah

Mathematica Policy Research

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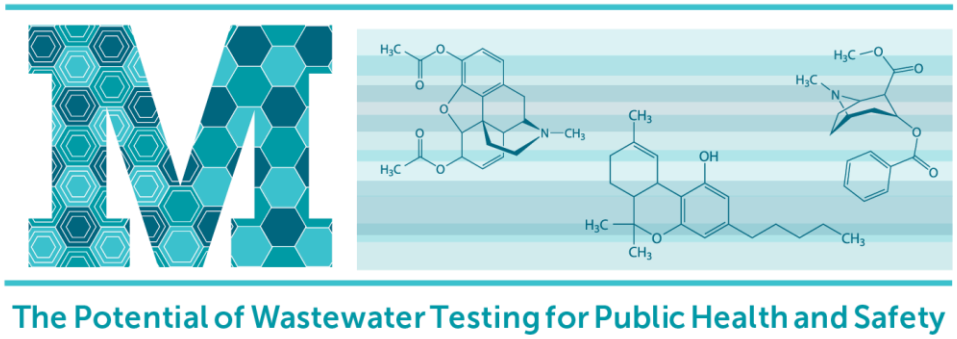
Policy Research



Can Wastewater Testing Improve Public Health and Well-Being?

Wastewater Symposium
Washington, DC

May 16, 2017

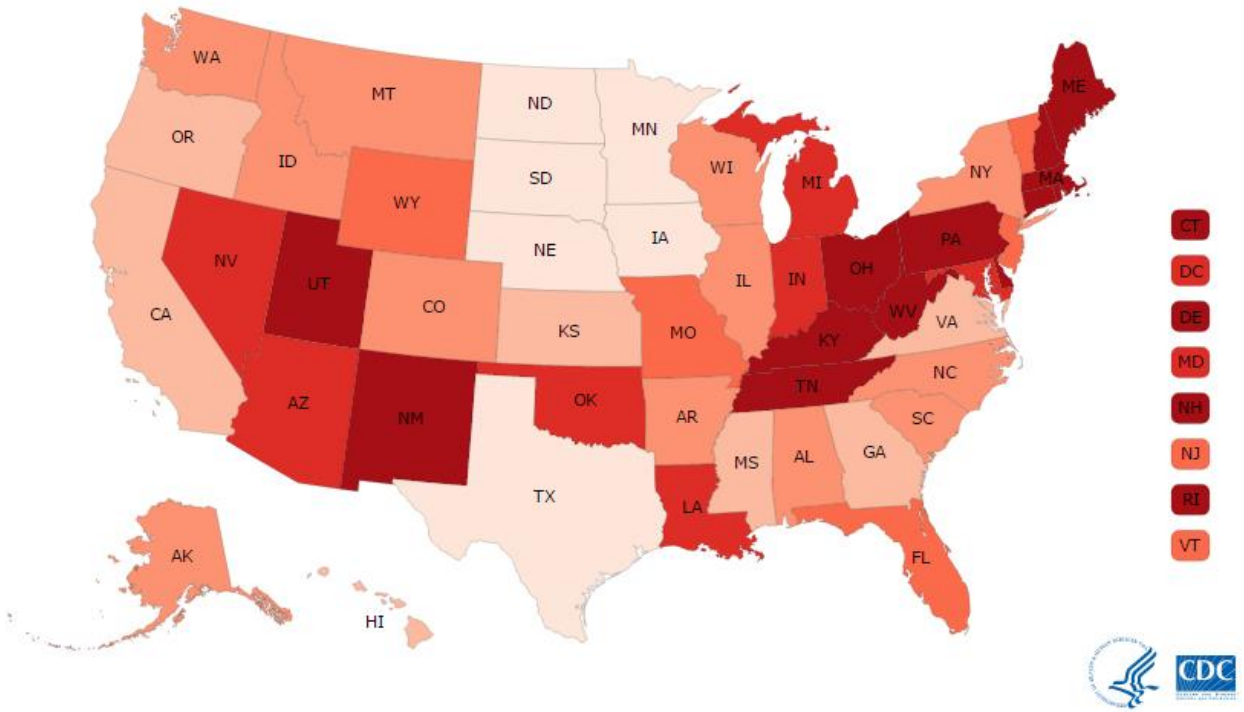
Aparna Keshaviah, Sc.M.

Thanks…

Substance Abuse and the Opioid Epidemic

Scope of the Opioid Epidemic

Number and age-adjusted rates of drug overdose deaths by state, US 2015



- **Costs = $42B/yr**
- **2015: 33,000+ OD deaths**
- **Rural & Urban**
  - **Increases in nearly every U.S. county**
  - **Prescription use differs: recreational vs workplace injury**

Complexities of Studying Drug Use

UNINTENDED CONSEQUENCES

Policy Ex. 1
Legalize marijuana

→ Shift in drug production: marijuana to heroin

Policy Ex. 2
Curb over-prescribing

→ Shift in affordability: prescriptions to heroin

↓

Increased transmission of HIV, Hepatitis C from injecting drugs

Complexities of Studying Drug Use

MULTIPLE STAKEHOLDERS

Policy Ex. 1
Legalize marijuana

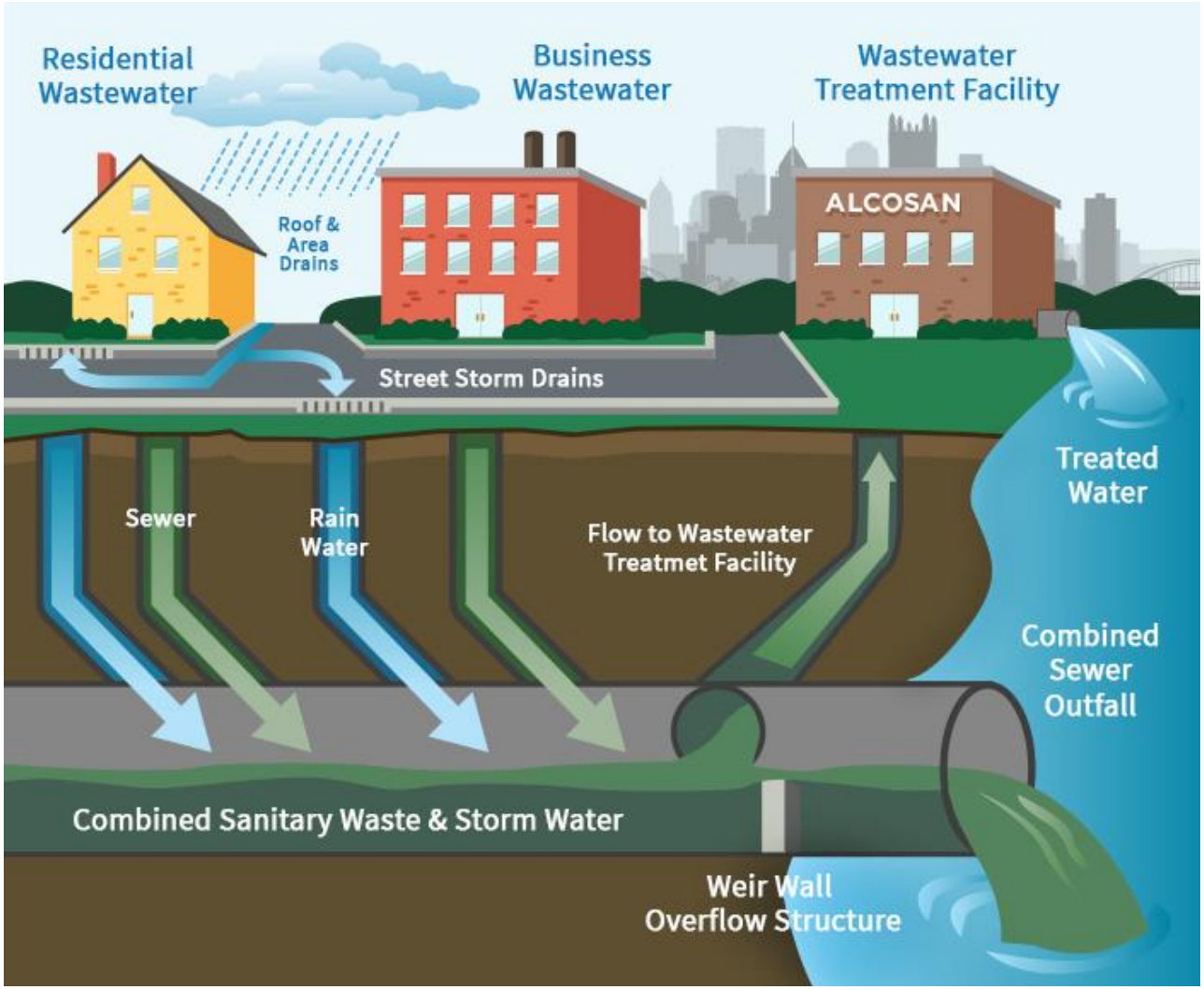
CO state legislature (amendment 64)
Local marijuana distributors, wholesalers
Illicit growers, transporters, security
Sinaloa cartel
Border patrol

Policy Ex. 2
Curb over-prescribing

FL Governor (bill HB 7095)
FL prescribing physicians
FL pharmacies (online)
WV Drug users
WV (Huntington) police

Wastewater:
A ‘New’ Data Source

Overview of Wastewater Testing



- **Mandatory sampling**
- **Routine testing for (90+ contaminants)**
- **Identity-blind data**

Benefits & Barriers

Benefit

- **Near real-time information**
- **Fairly comprehensive coverage**
  - 81% of U.S. households
- **Standardized infrastructure to study program impacts**
- **Unbiased reporting versus:**
  - Surveys: Non-response, underreporting
  - Medical data: Requires medical visit
  - Crime data: Vary by resource allocation
- **Enables study of emerging substances & interactive effects**

Barrier

- **Lack of awareness**
- **Methods not fully developed**
  - detection limits
  - non-routing testing for drugs
- **Calibration needed**
  - Sewer designs & operation
  - Rainfall amounts
  - Population changes (events/tourism)
- **Cross-agency coordination (who oversees? who pays?)**

Potential Uses of Wastewater

Snapshots: Understand what drugs are being used

- Identify emerging substances

Trends: Calculate rates of change in use over time

- Test effectiveness of a new program or policy

Hotspots: Identify geographic concentrations of use

- Useful for resource allocation

Pair with other sources synergistically

Symposium Overview

TOPICS Wastewater + Public health/safety needs
(methods) + (applications)

FORMAT Presentation
↓
Panel
↓
Q&A

OUTPUT Alignment in needs across domains
Cross-cutting goals, shared purposes

For More Information

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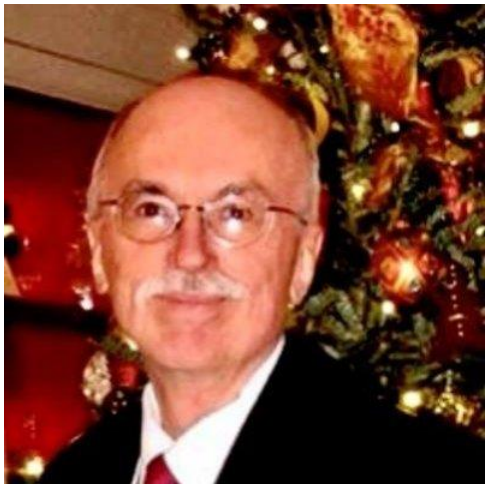
II. Information gaps that inhibit effective policy development



Terry Zobeck

Office of National Drug Control Policy

II. Information gaps that inhibit effective policy development

Chris Jones

Office of the Assistant Secretary for Planning and Evaluation

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Policy Research

The Opioid Epidemic:

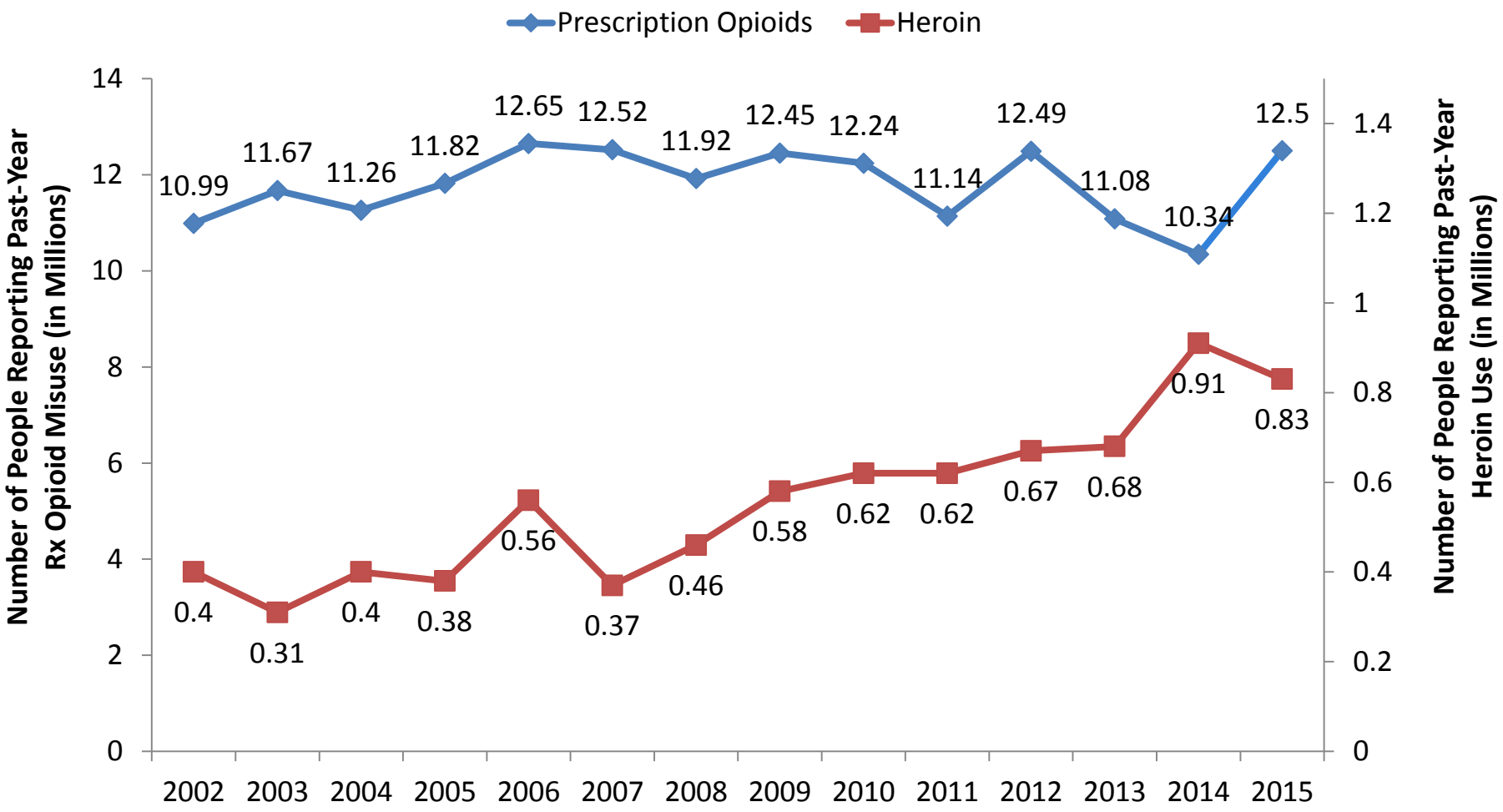
Epidemiology and Surveillance

Wastewater Symposium
Washington, DC

May 16, 2017

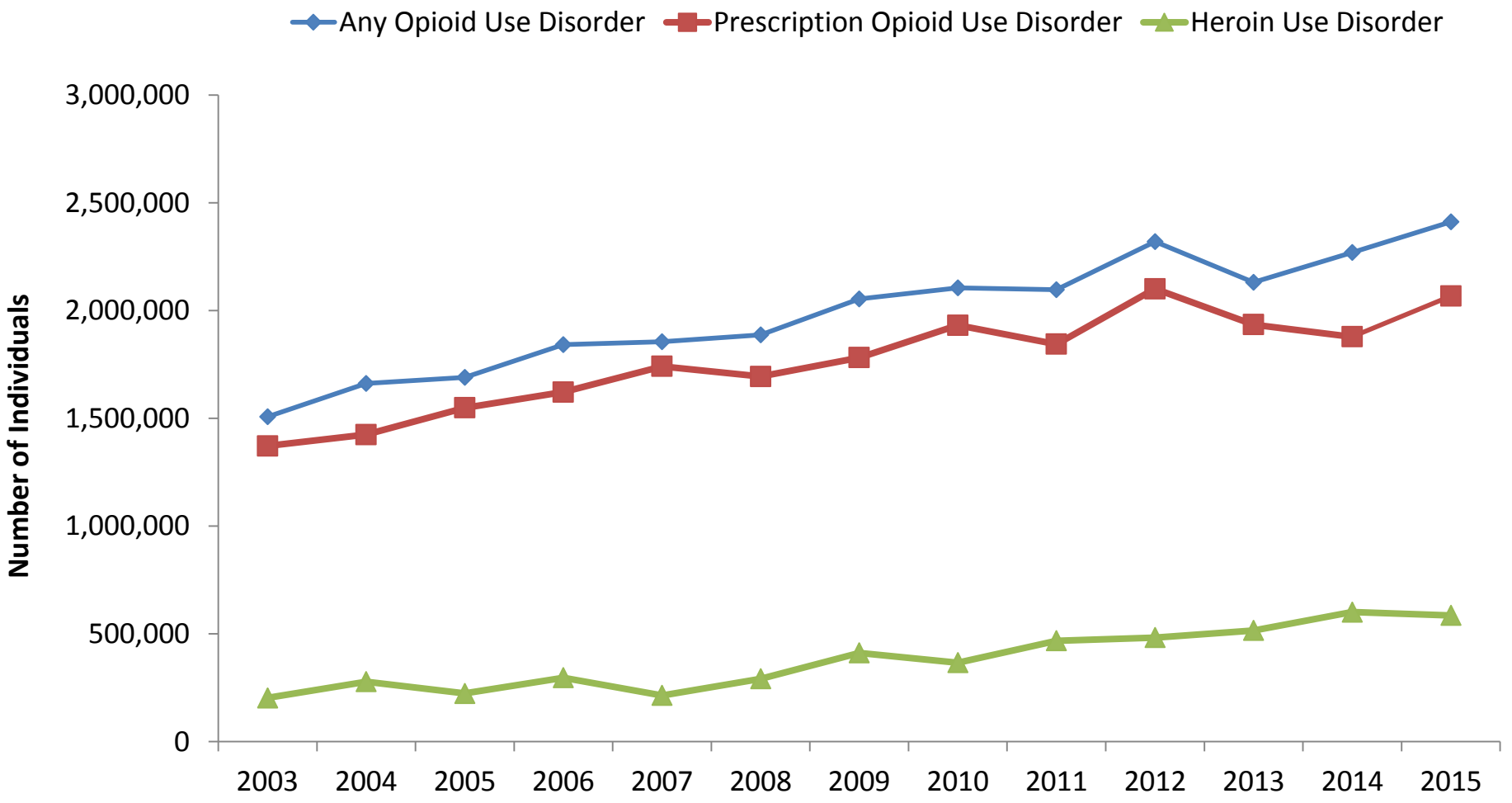
Christopher M. Jones, Pharm.D., M.P.H.
Acting Associate Deputy Assistant Secretary, Science and Data Policy
Office of the Assistant Secretary for Planning and Evaluation
U.S. Department of Health and Human Services (HHS)

Trends in Past-Year Misuse of Rx Opioids and Heroin Use



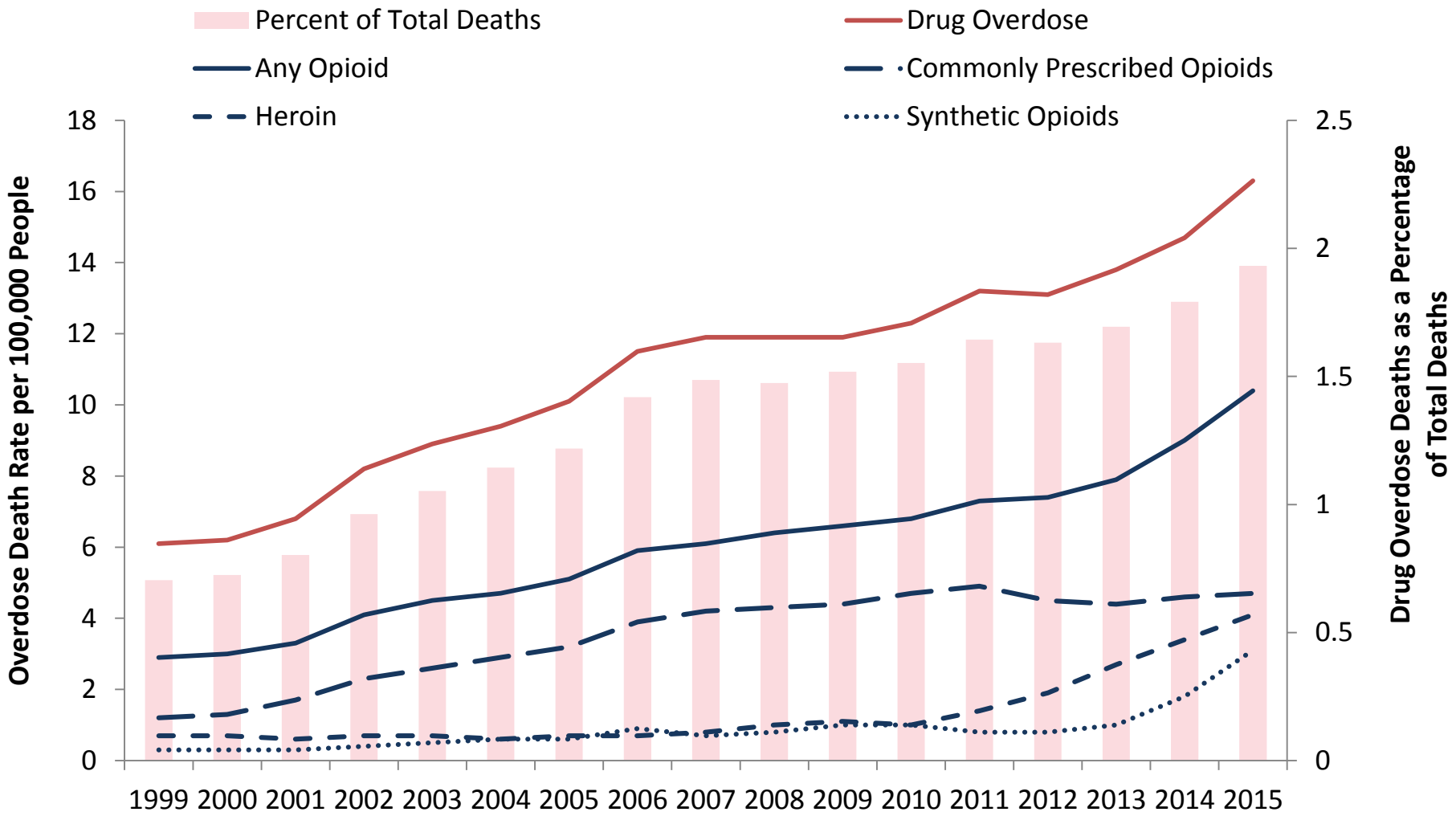
Source: Substance Abuse and Mental Health Services Administration's National Survey on Drug Use and Health (NSDUH) 2002–2015.

Trends in Opioid Use Disorder



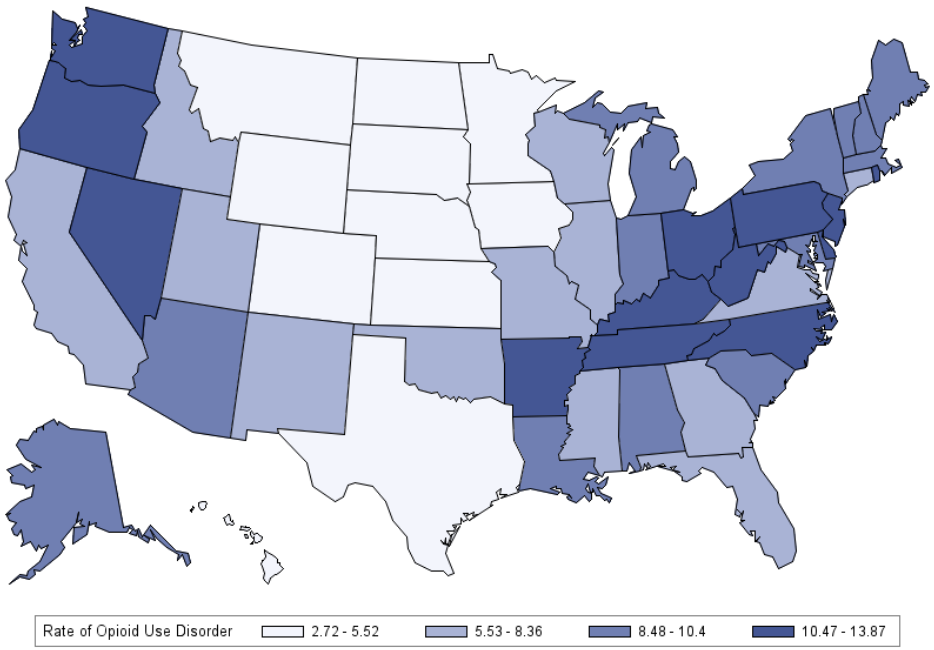
Source: Jones, C.M., analysis of the NSDUH 2002–2015, PUF.

Trends in Overdose Deaths

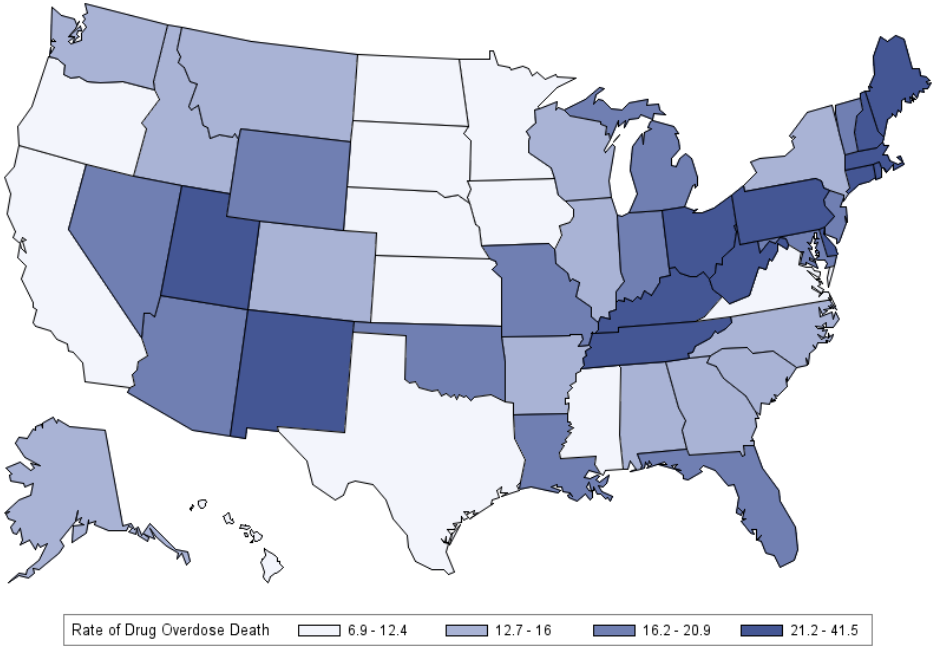


Rates of Opioid Use Disorder and Drug Overdose Deaths by State

Rate of Opioid Use Disorder



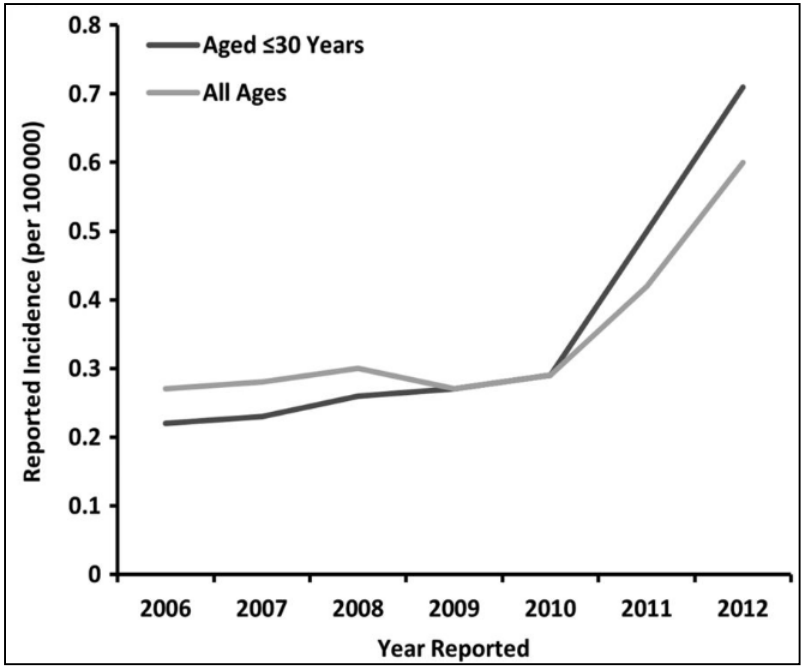
Rate of Drug Overdose Deaths



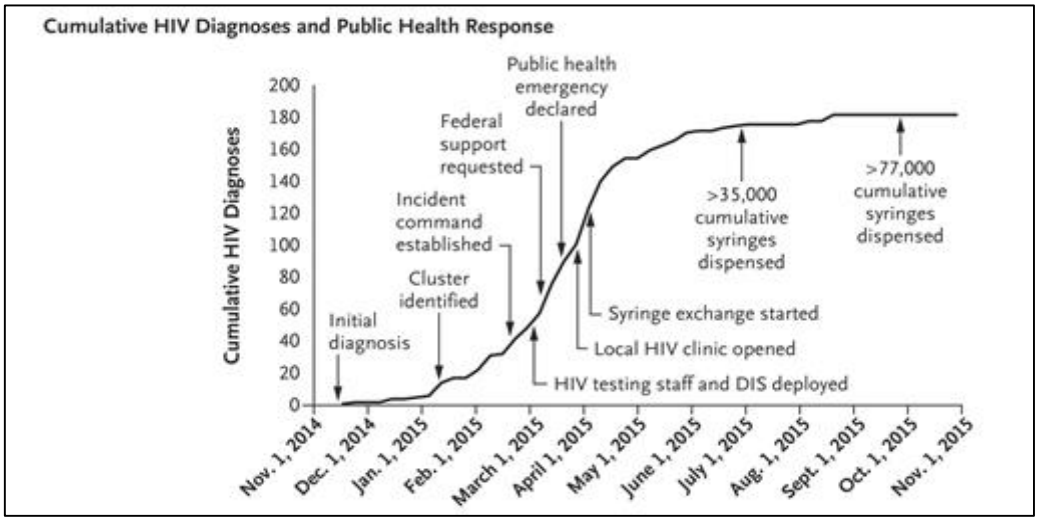
Source: Jones, C.M., unpublished analyses of NSDUH 2011–2014; Centers for Disease Control and Prevention's (CDC's) National Vital Statistics System (NVSS) (2015).

Opioid Epidemic and Increasing Injection Drug Use

Rising rates of hepatitis C (HCV)

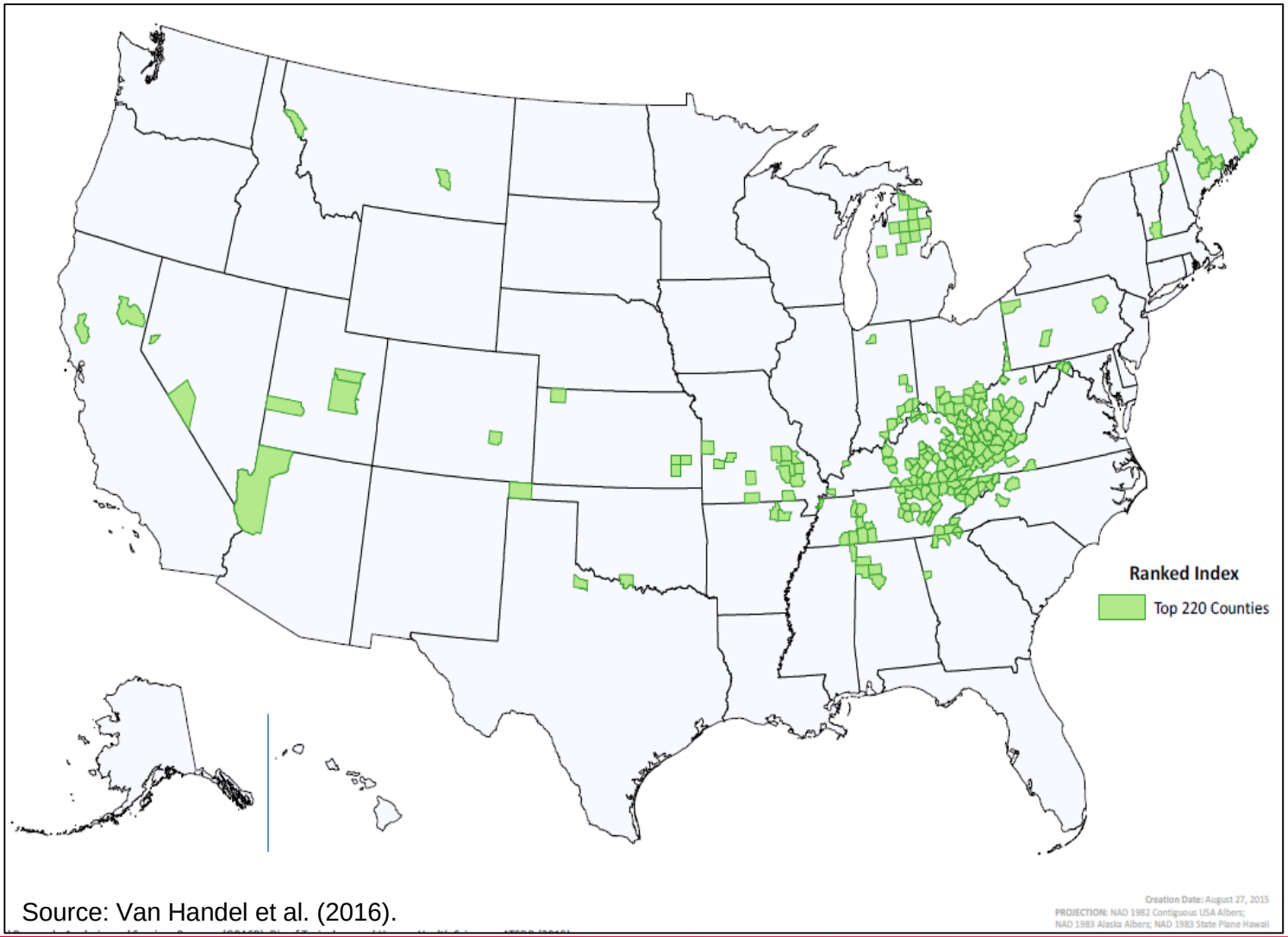


HIV outbreak in Scott County, Indiana, in 2015



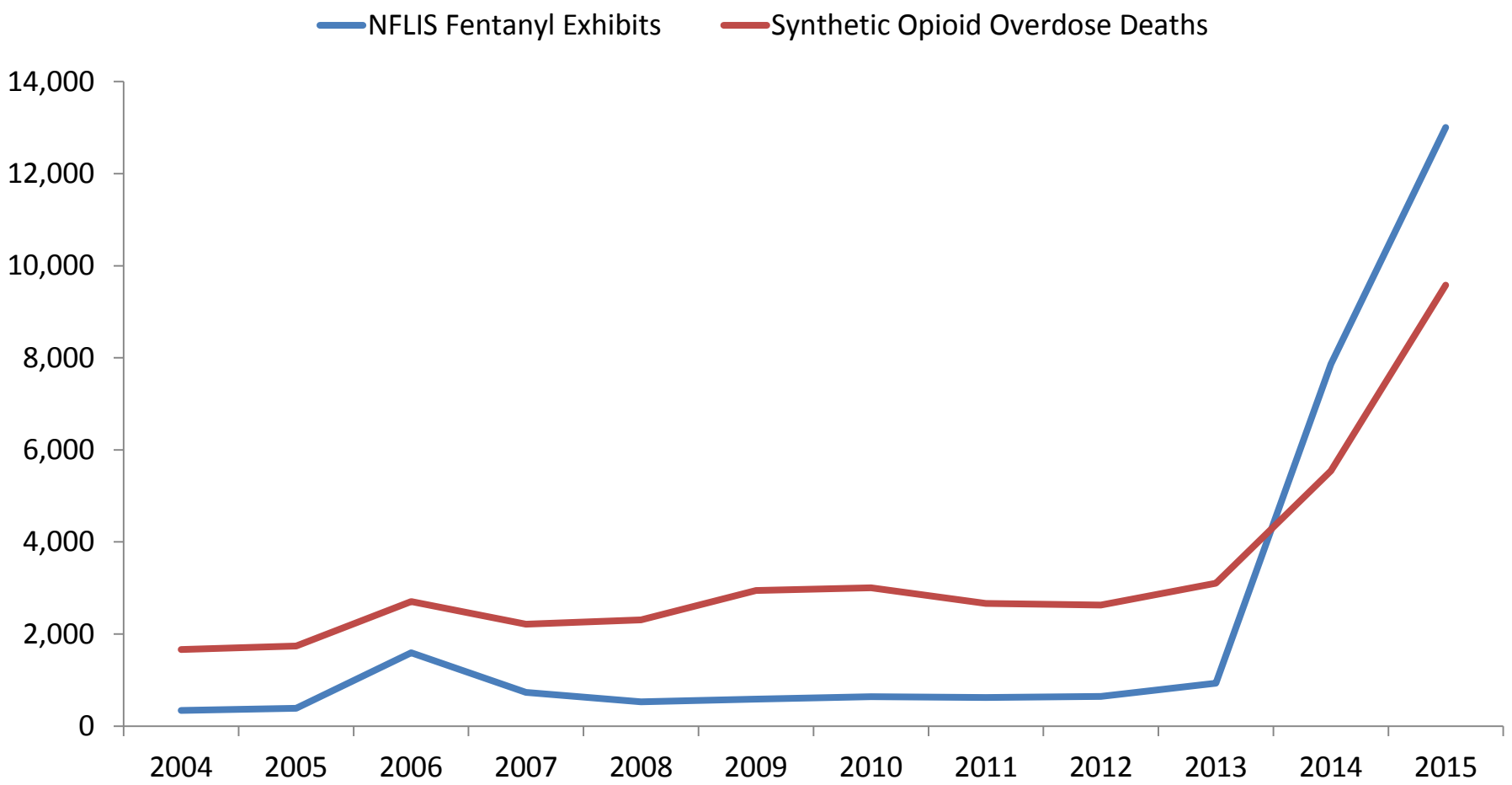
Source: Suryaprasad et al. (2014); Peters et al. (2016).

Counties Deemed Highly Vulnerable to Rapid Spread of HCV or HIV



Source: Van Handel et al. (2016).

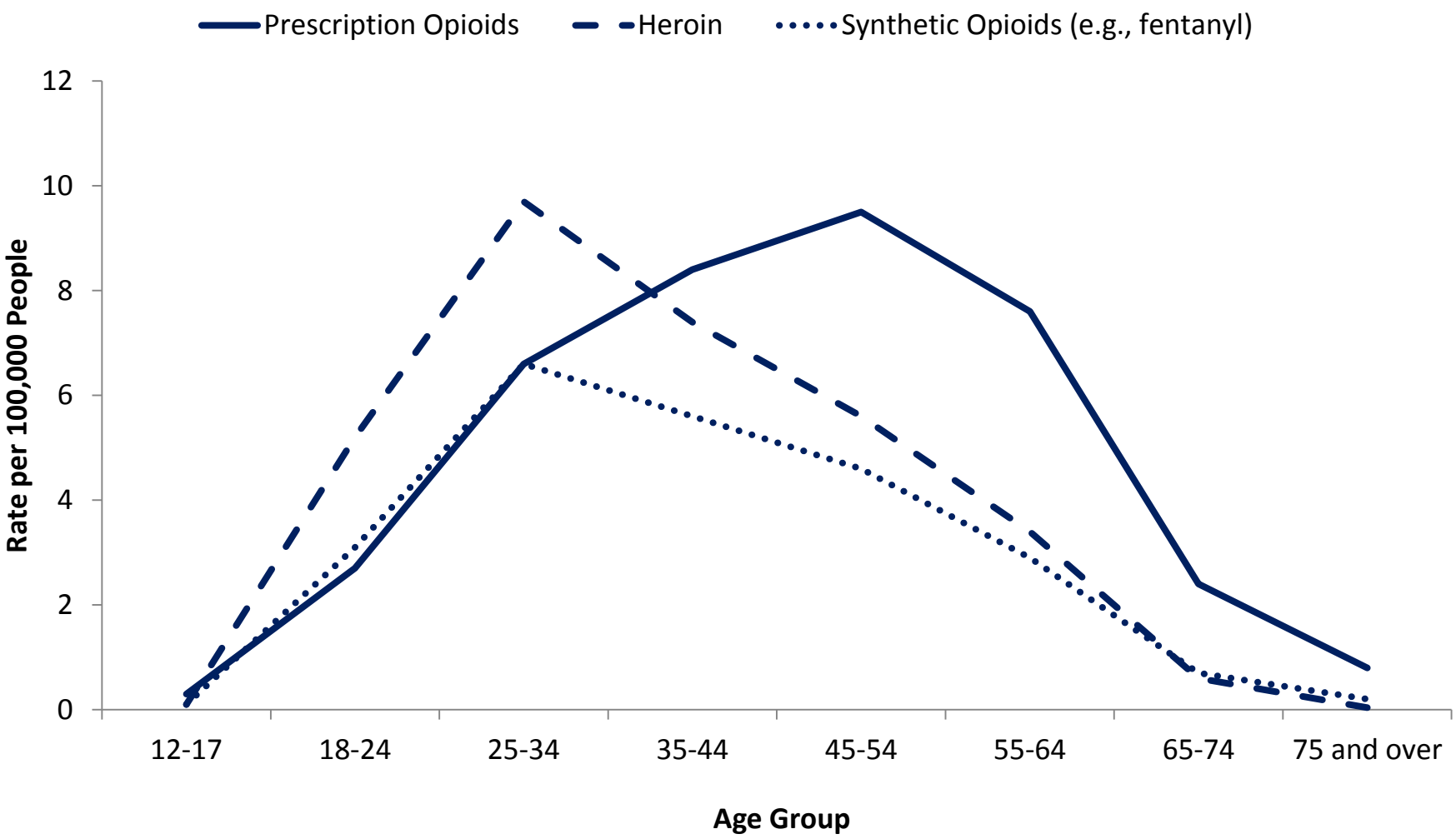
Synthetic Opioid Deaths Closely Linked to Illicit Fentanyl Supply



Source: Drug Enforcement Administration; CDC's NVSS (2017).

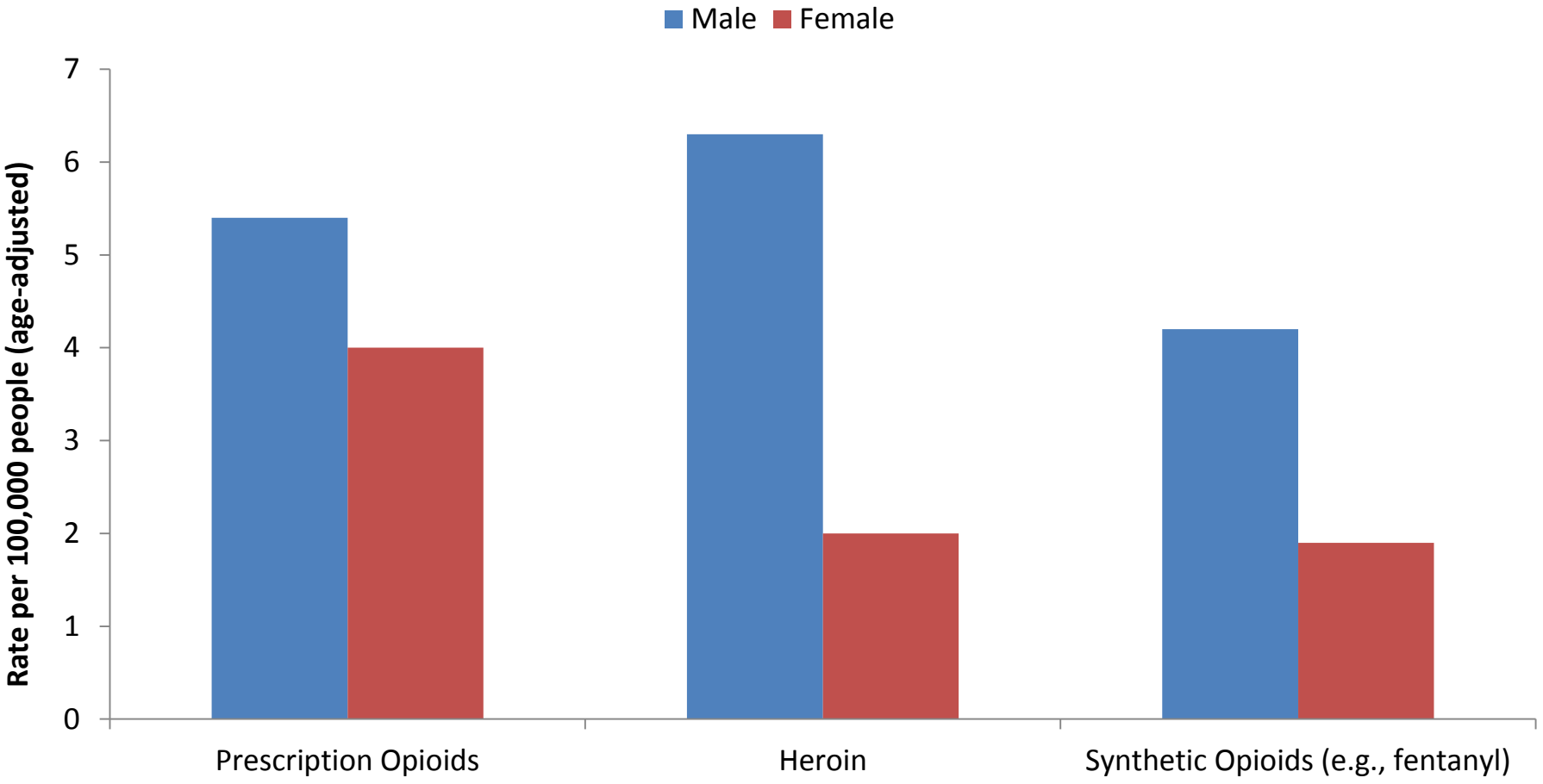
NFLIS = National Forensic Laboratory Information System.

Age Distribution of Opioid Deaths in 2015



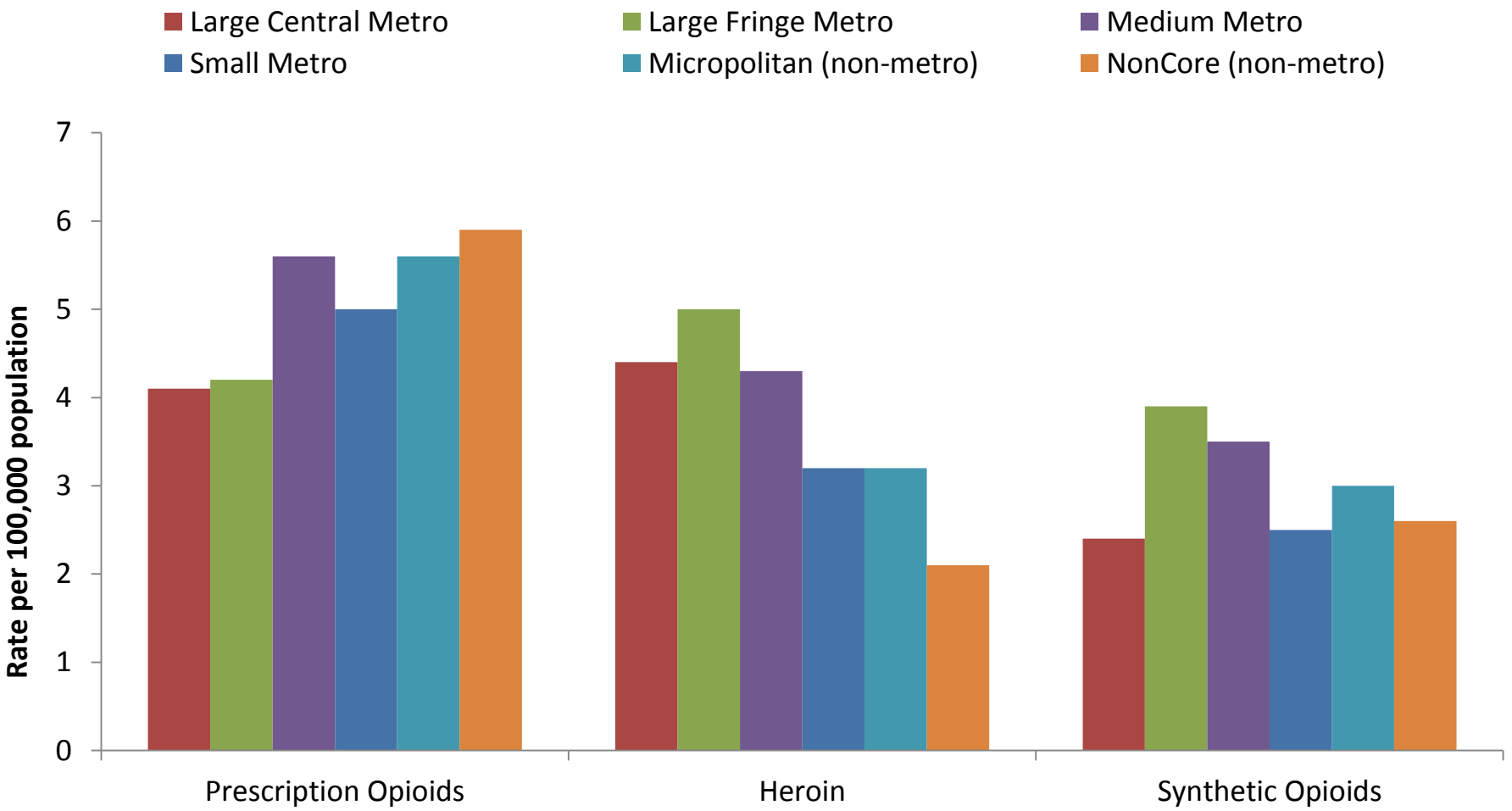
Source: CDC's NVSS (2016).

Opioid Overdose Deaths by Sex, 2015



Source: CDC's NVSS (2016).

Opioid Overdose Deaths by Urbanicity, 2015



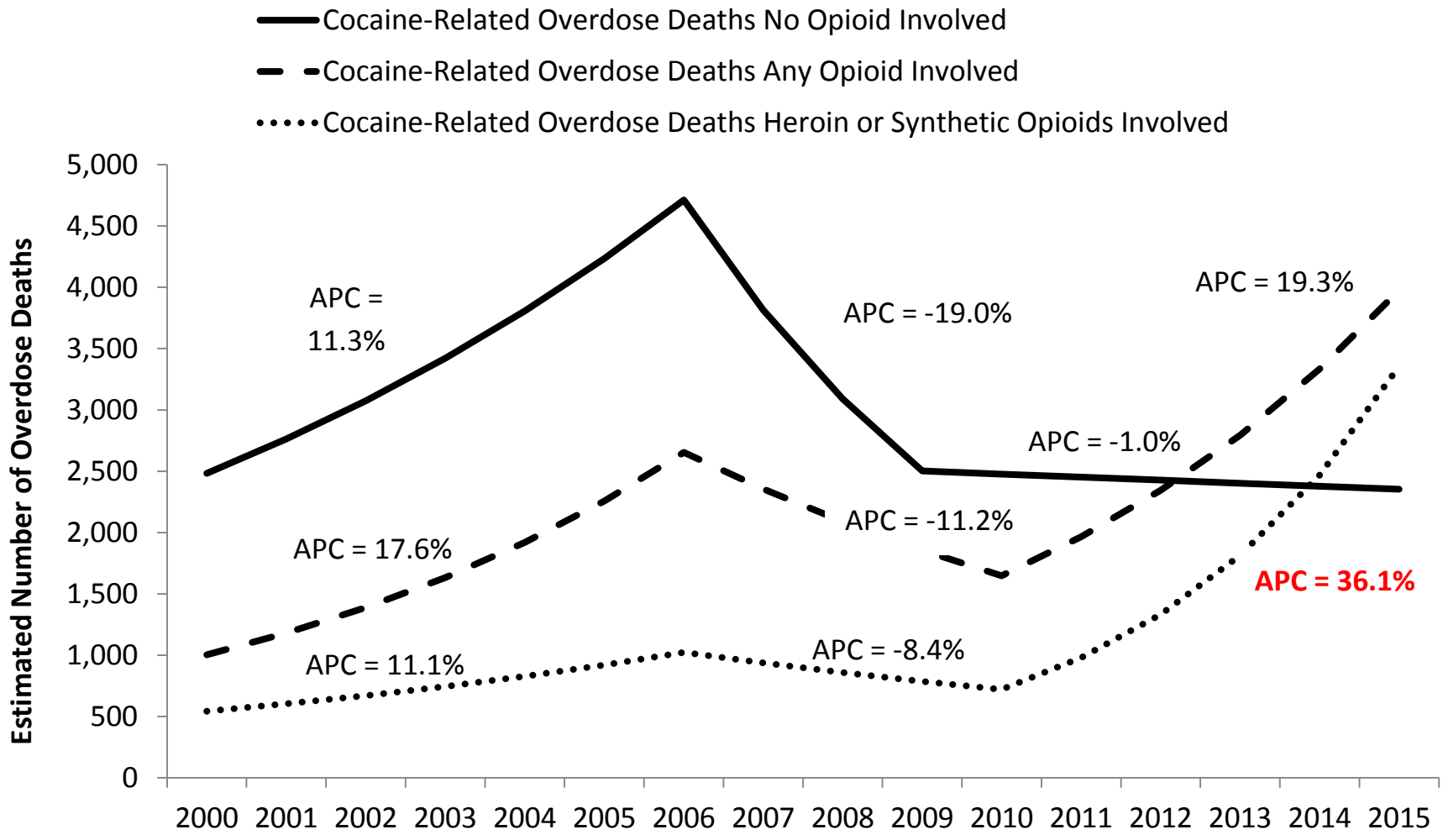
Source: CDC's NVSS (2016).

Fentanyl and Counterfeit Products Broaden At-Risk Population

- Reports of fentanyl being pressed into counterfeit tablets and sold as commonly abused opioids and benzodiazepines
- Reports of people who thought they were using cocaine but were actually using fentanyl

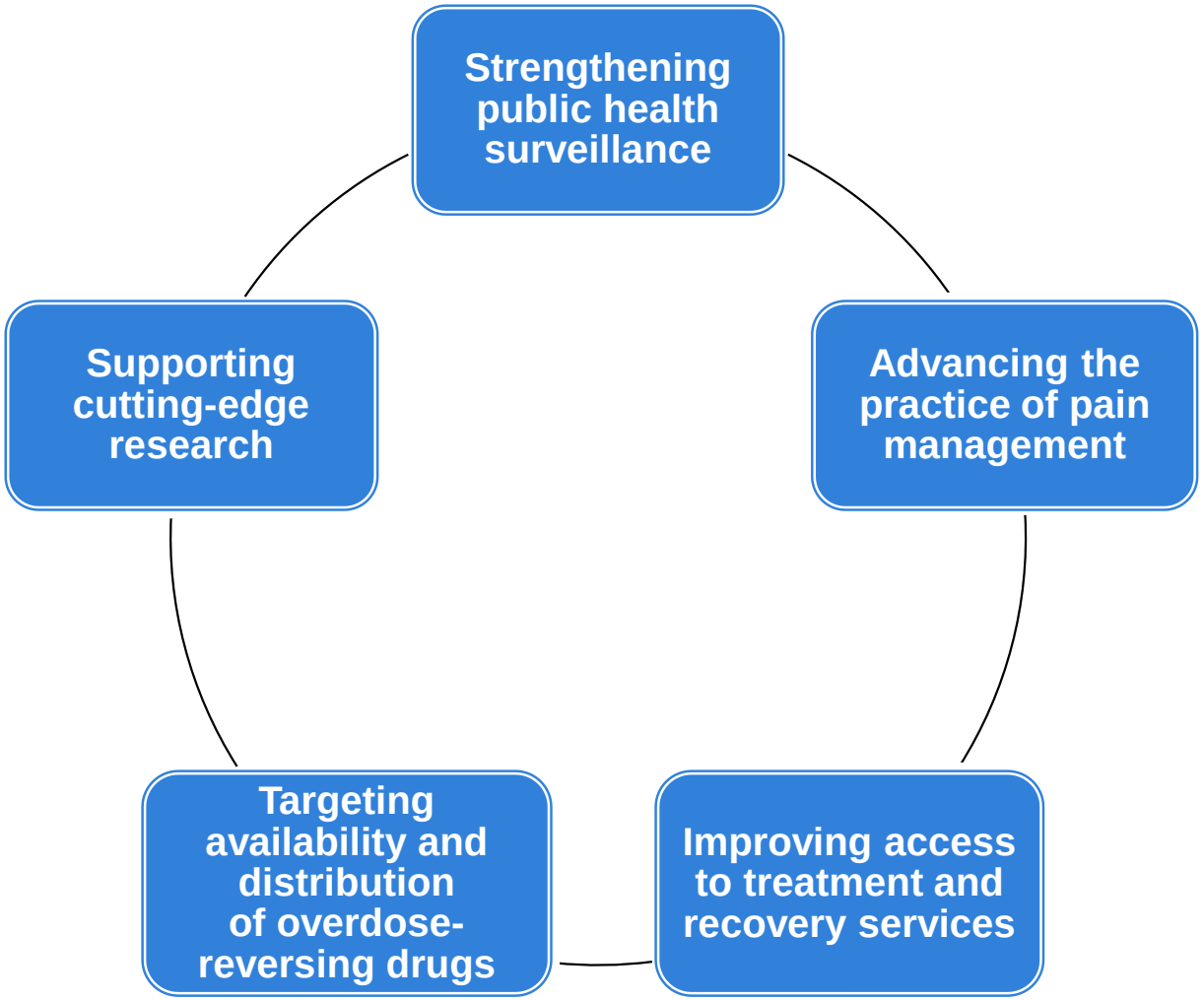

Figure 3: Counterfeit 30 Milligram Oxycodone Pills Containing Fentanyl.

Heroin and Synthetic Opioids Driving Increase in Cocaine-Related Deaths



Source: Jones et al. (2017).

HHS Opioid Strategy



- **Surveillance goal: improve timeliness and specificity of surveillance activities to inform policy and programmatic efforts**
- **This will help HHS be prepared for and responsive to the evolving epidemic**

For More Information

- Christopher Jones
  - Christopher.Jones@HHS.GOV

Audience Q&A

Looking ahead to the next three to five years, do you think wastewater testing should focus on:

- **A) Opioids**
- **B) Cocaine**
- **C) Marijuana**
- **D) Emerging substances**
- **E) All of the above**

III. Public health applications of wastewater testing

Dan Burgard
University of Puget Sound

Caleb Banta-Green
University of Washington

Kevin Bisceglia
Hofstra University

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Wastewater Testing:

A Pipeline to Public Health Data

Wastewater Symposium
Washington, DC

May 16, 2017

Daniel A. Burgard • Kevin Bisceglia • Caleb Banta-Green

What Are Drug Epidemiology Goals? (broadly applies to other health behaviors)

- Track changes in use over time
  - Evaluate intervention impacts
  - Changes in use or supply
- Determine level of use (absolute or relative)
  - Determine prevalence
  - Prioritize interventions
- Identify/document new drugs
  - Identify new/incidental use
  - Alert public
  - Determine interventions

Drug Abuse Surveillance—Current Limitations

- Lack of geographic resolution: current surveys provide national-level drug use/abuse data but little at the state or substate level
- Lack of temporal resolution (annual data) and timely availability
- Population coverage: Large portion of drug-using community is currently excluded
- Small number of “events” in many jurisdictions
- Specific/actual drugs

Examples of Measurement Bias

- Mortality data: only true population-level data
  - "Tip of the iceberg" because mortality is biased toward more lethal drugs and lags behind entrance of drugs into the "market"

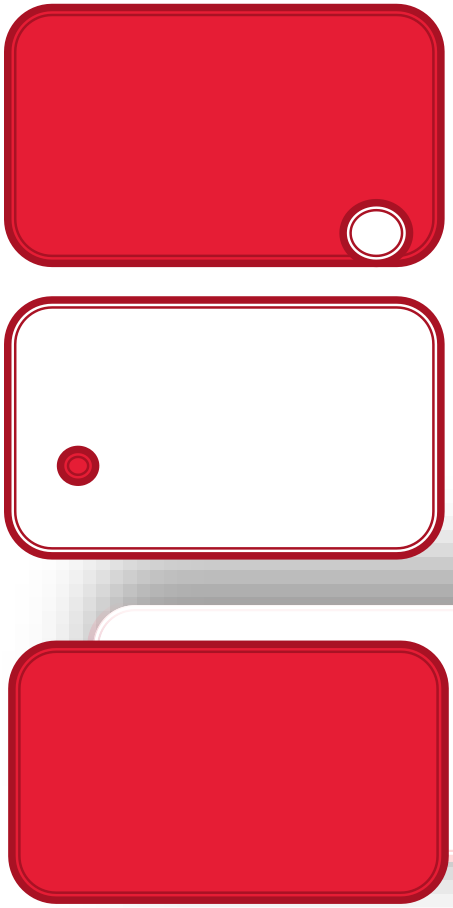
- Current surveys usually:
  - Rely on self-reporting
  - Exclude populations such as prisoners

- Calls to poison control centers may decline as physicians recognize drug-related health problems and gain experience in treatment

Essential Data Comparison Problem

WW is total population

Common data issues



Missing highest-frequency users

Only high-frequency users

Populations being compared don’t align well

Raw Wastewater Influent

- Conveniently “focused” and sampled at a central location
- Least amount of degradation compared with effluent
- Preserves people’s privacy
- Samples collected daily
- Known flows for calculation of loads

http://www.kingcounty.gov/environment/wtd/About/System/West.aspx

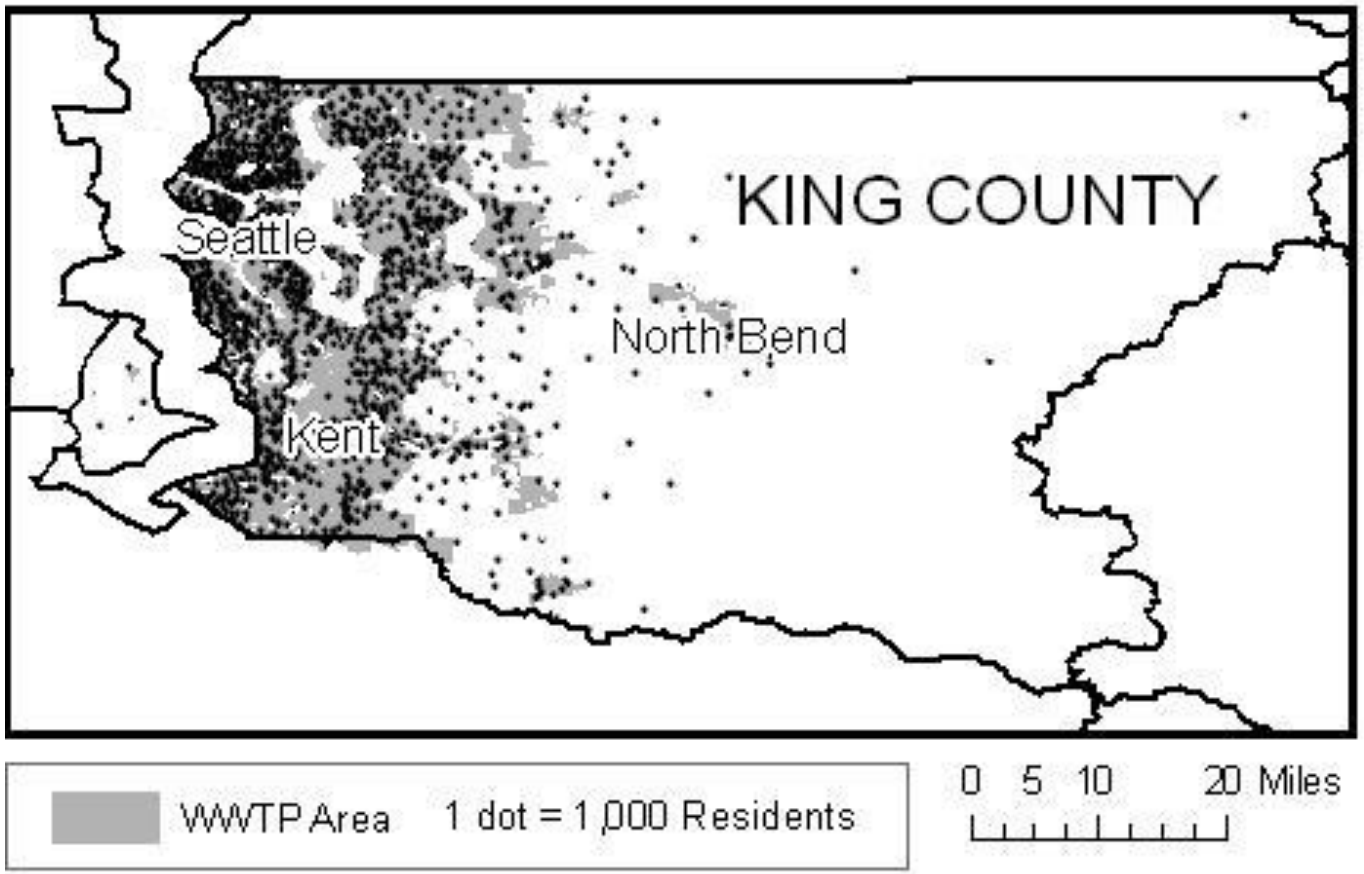
Attributes of Data Derived from Wastewater Treatment Plants (WWTPs) (1)

- Cover much of the population
  - But areas with septic systems are not covered
- Known catchment areas
- Generally follow political boundaries
  - Aids comparisons with other data types
  - Increases utility for local planners
- GIS/mapping data often available from local municipalities

Attributes of Data Derived from WWTPs (2)

- Compound/drug specific
- Timely—available with short lag
- Time scalable (within day, day, month, year)
- Geographically scalable (could aggregate municipalities or go “upstream”)

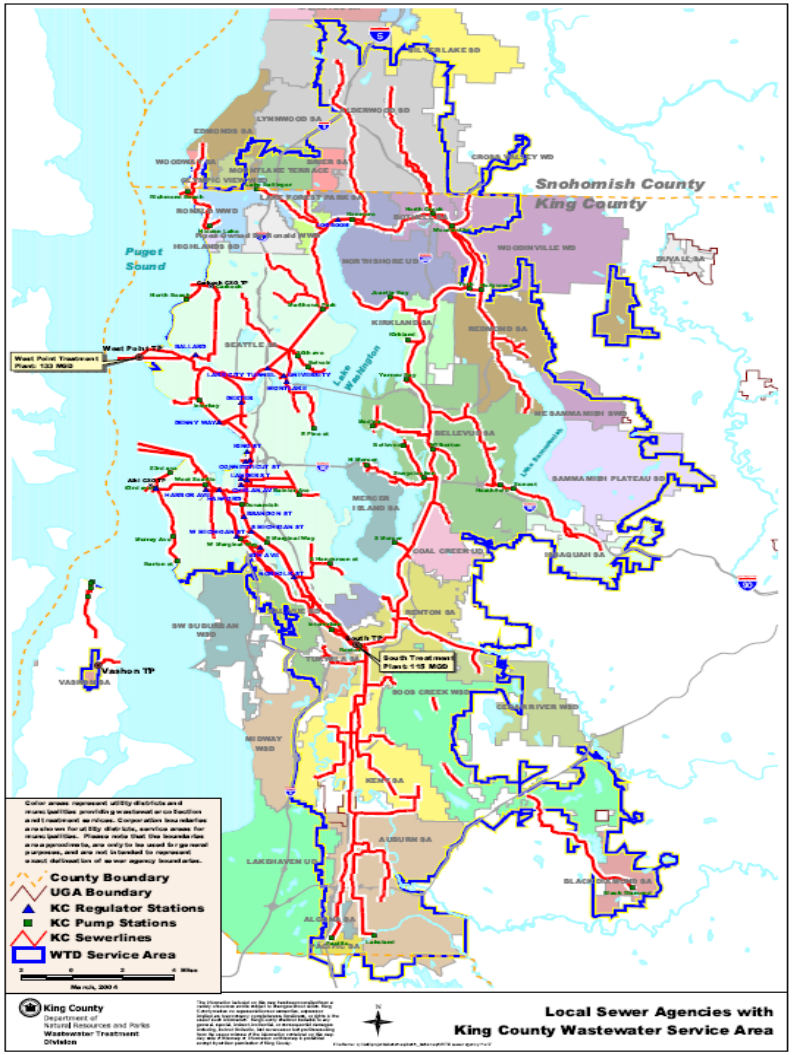
Population Covered by WWTP



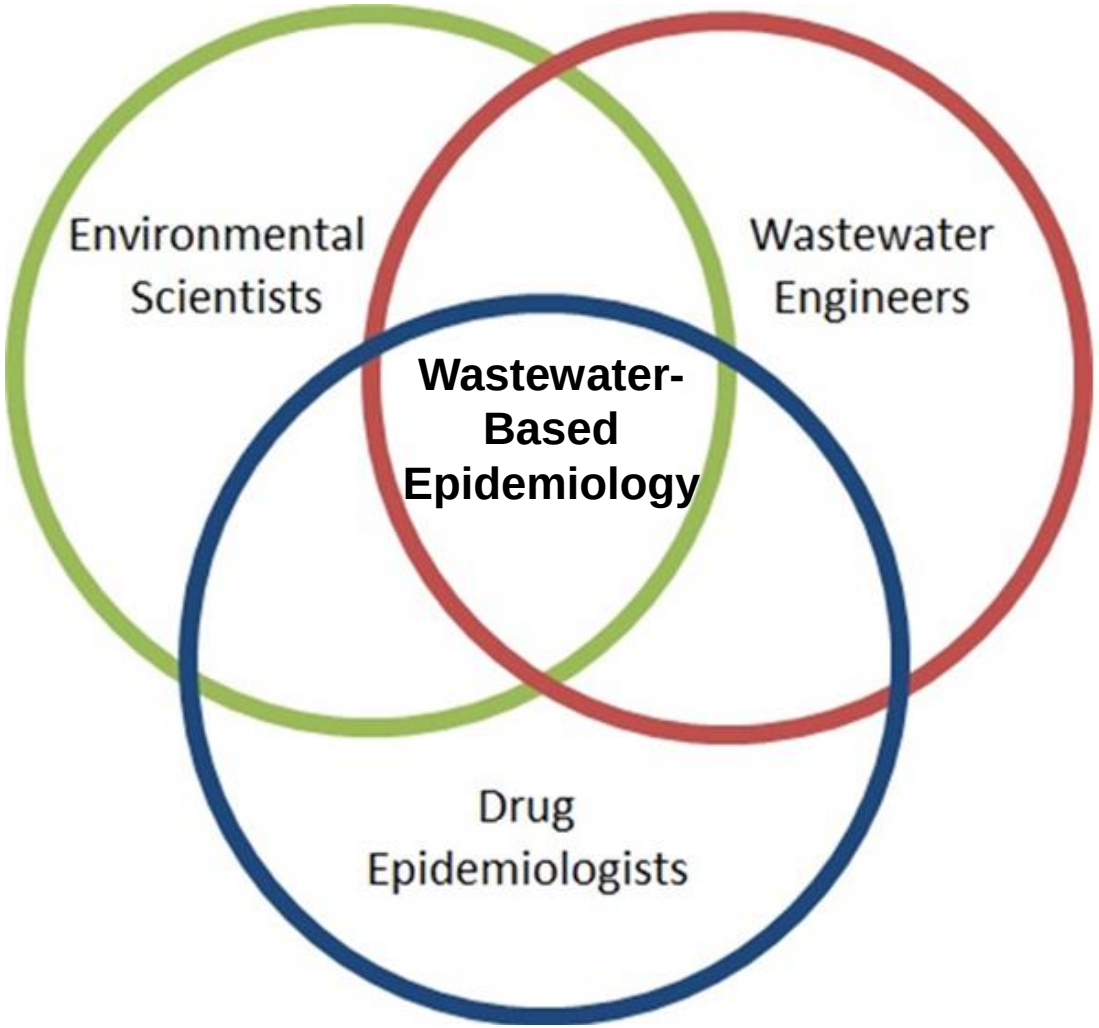
WWTPs cover 85% of the population of King County, Washington, based on place of residence: 1,482,427 of 1,737,034 residents

Wastewater Catchment Areas for King County

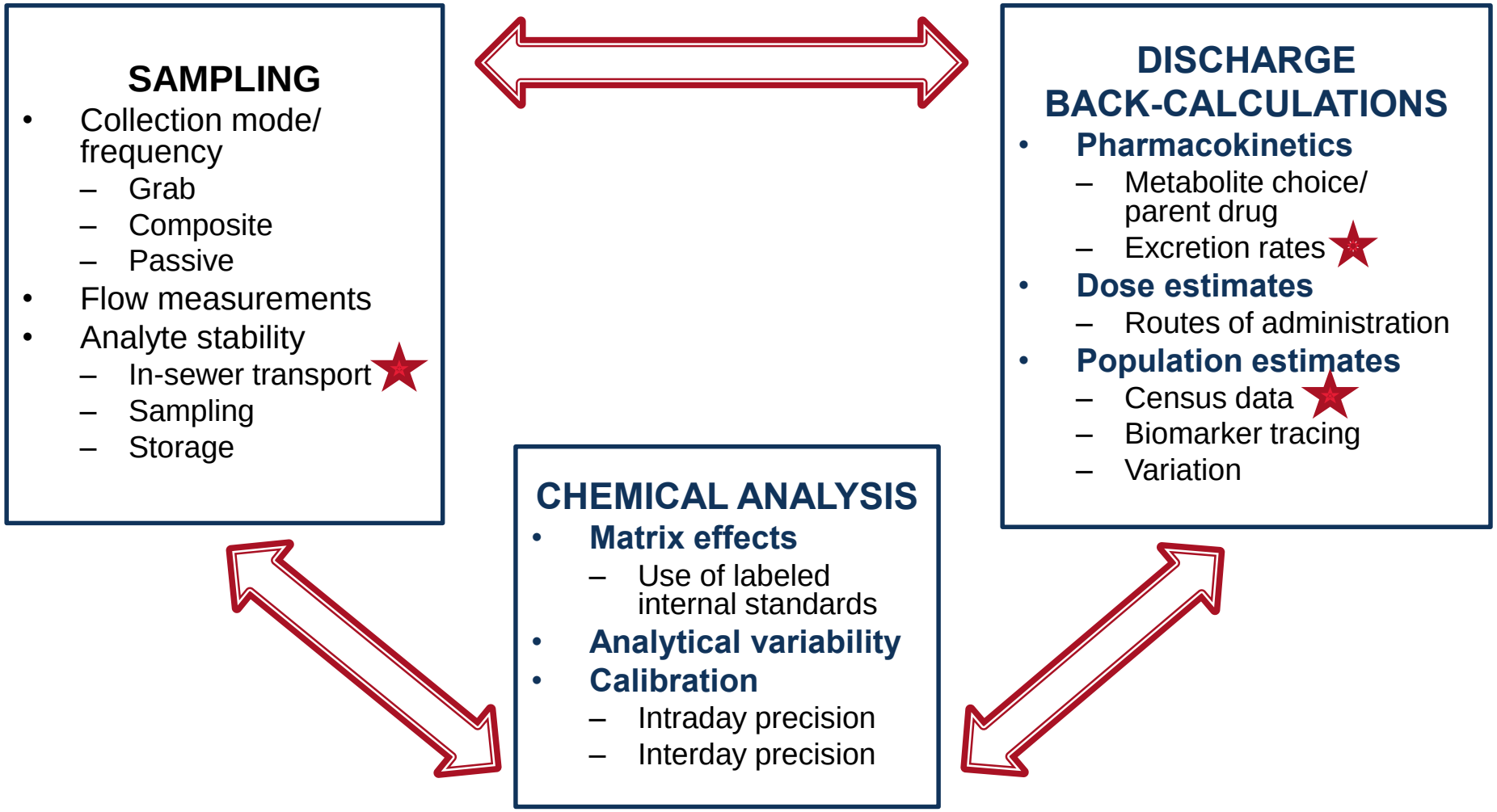
- Multiple places
- Moderate size
- Alignment with cities varies



Wastewater-Based Epidemiology

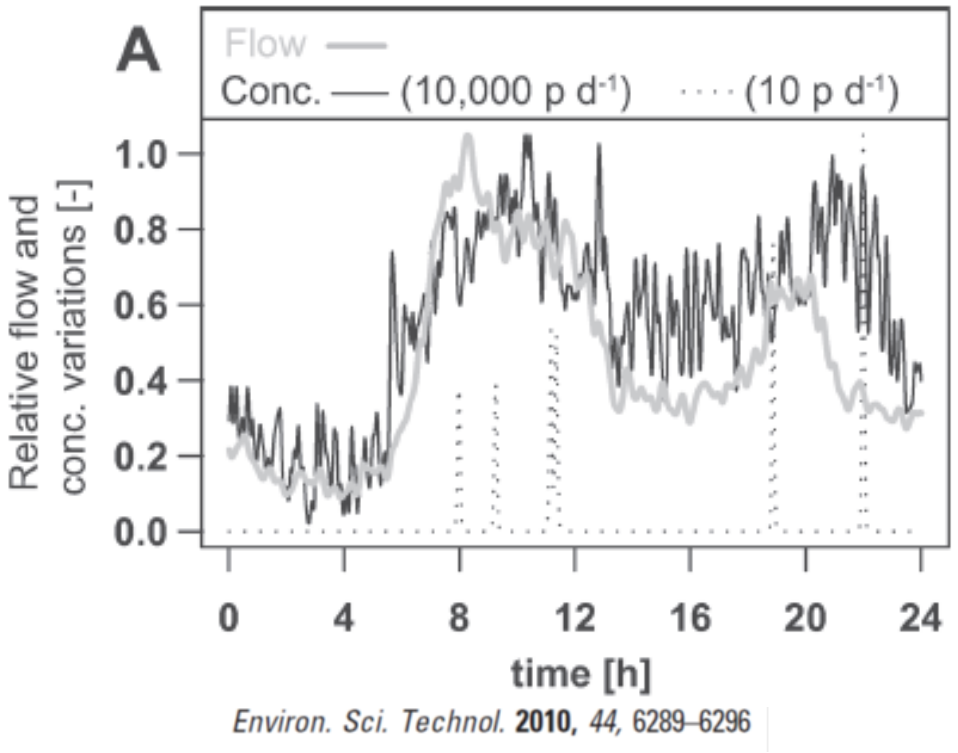


Factors Affecting the Utility of Wastewater-Based Epidemiology



Wastewater Testing

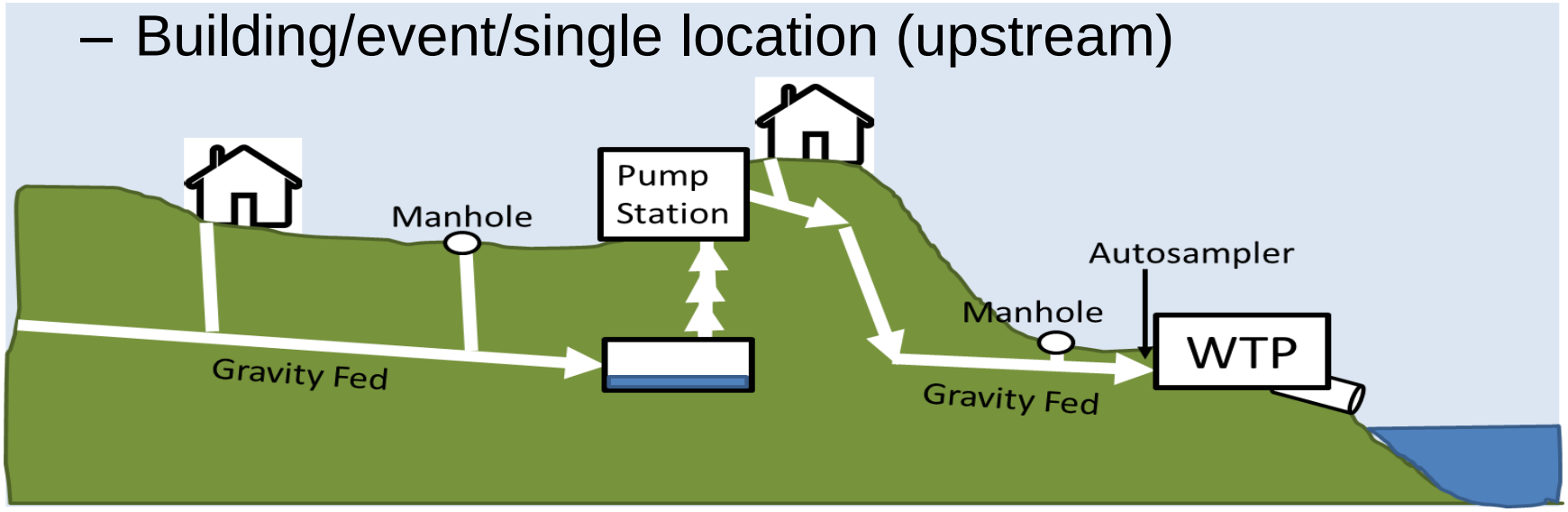
- Types of samples
  - Grab samples
  - Composite (24 hour) time volume, or flow
  - Passive sampling
- Approach and frequenc affect the results substantially



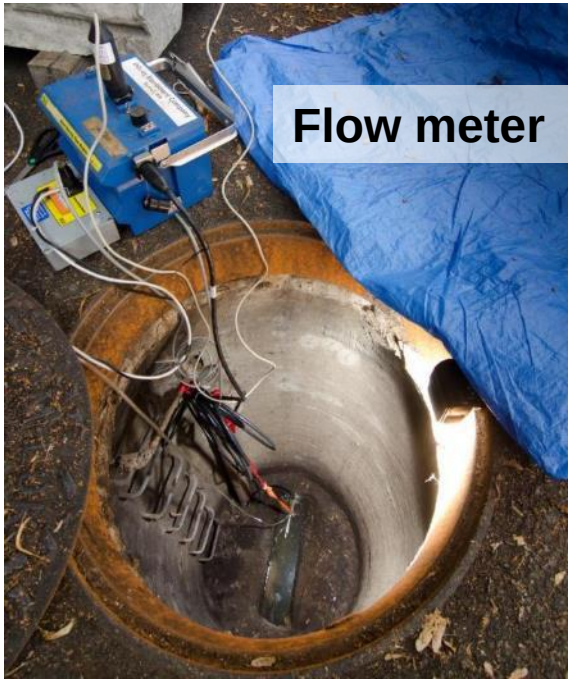
Environ. Sci. Technol. **2010**, *44*, 6289–6296

Wastewater Collection

- Wastewater conveyance systems
  - Gravity-fed with or without pumps stations
- Locations
  - Treatment plants (downstream)
  - Sewer system (midstream)
  - Building/event/single location (upstream)



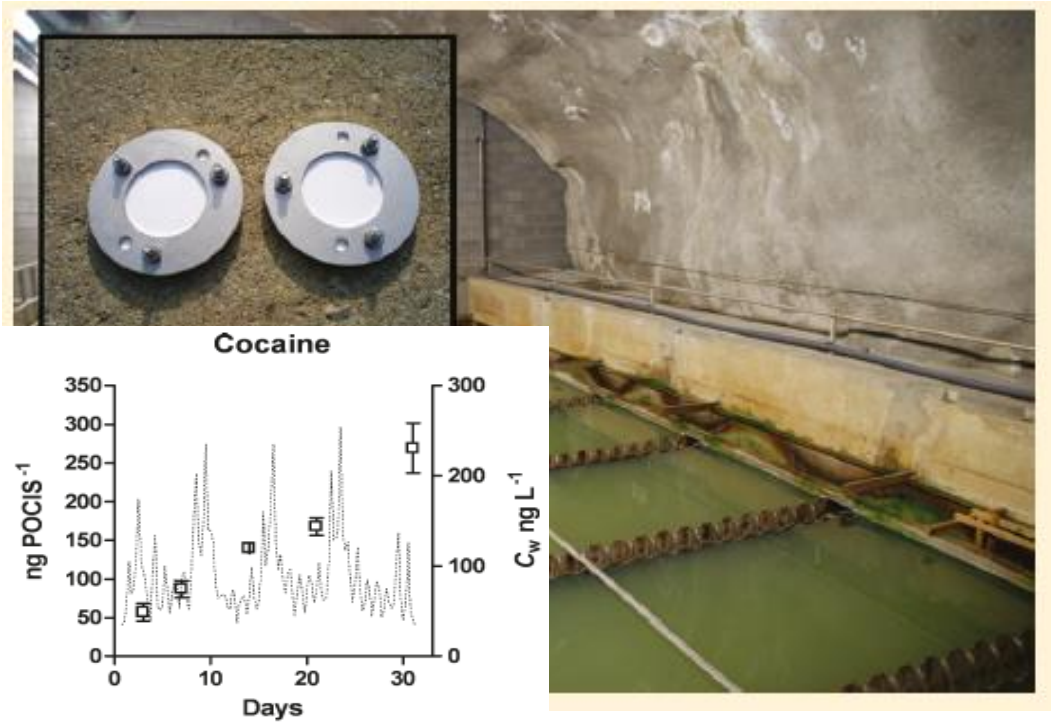
Wastewater Autosamplers



Passive Sampling

Deployed for 27 days

Sci. Total Environ. **2014**, *472*, 9-12



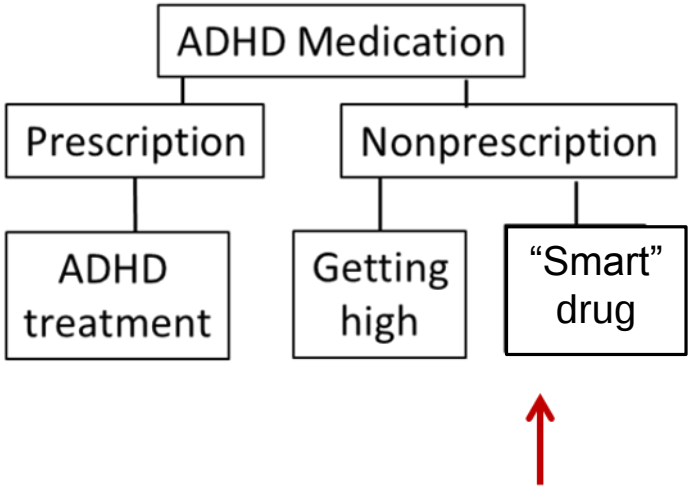
Deployed for five weeks compared with six-hour composites

Environ. Sci. Technol. **2011**, *45*(13), 5676-82

Wastewater as a Window into Public Health

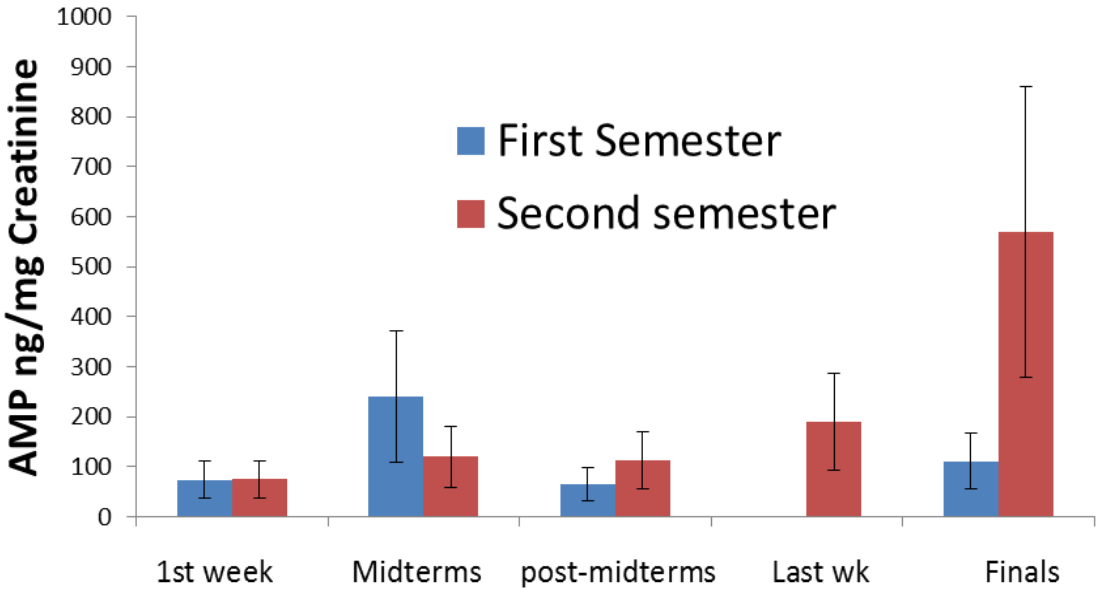
- Prescription compliance and prevalence of specific ailments and health behaviors
  - Tamiflu compliance during flu outbreaks
  - Tobacco and alcohol use
- "Big-picture" trends in population health
  - Broad-spectrum antibiotics and OTC pain medicines?
  - Endogenous biomarkers of stress?
  - Trends in obesity through changes in gut microbiome
- Pathogen surveillance
  - Polio, hepatitis, and other disease vectors—track or predict outbreaks in near-real time?
  - Antibiotic resistance?

College Case Study



This path should correlate with times of academic stress

Adderall—mixed amphetamine salts



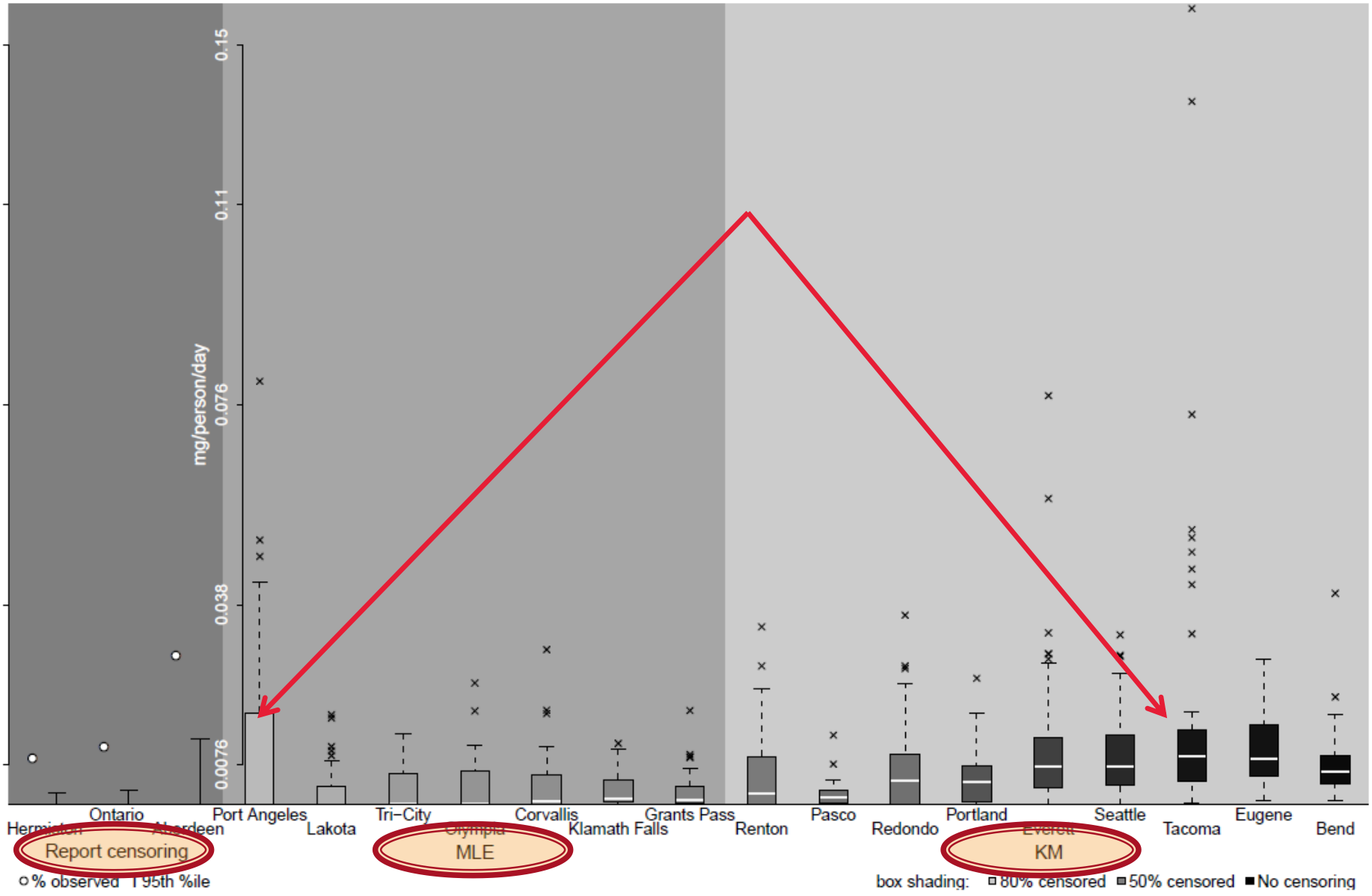


Figure 2: MDMA index load (mg/person/day) distribution

The label under the WWTP names and the background shading indicate which method is used to create the estimated yearly mean.

Methamphetamine Use in Washington State and Oregon

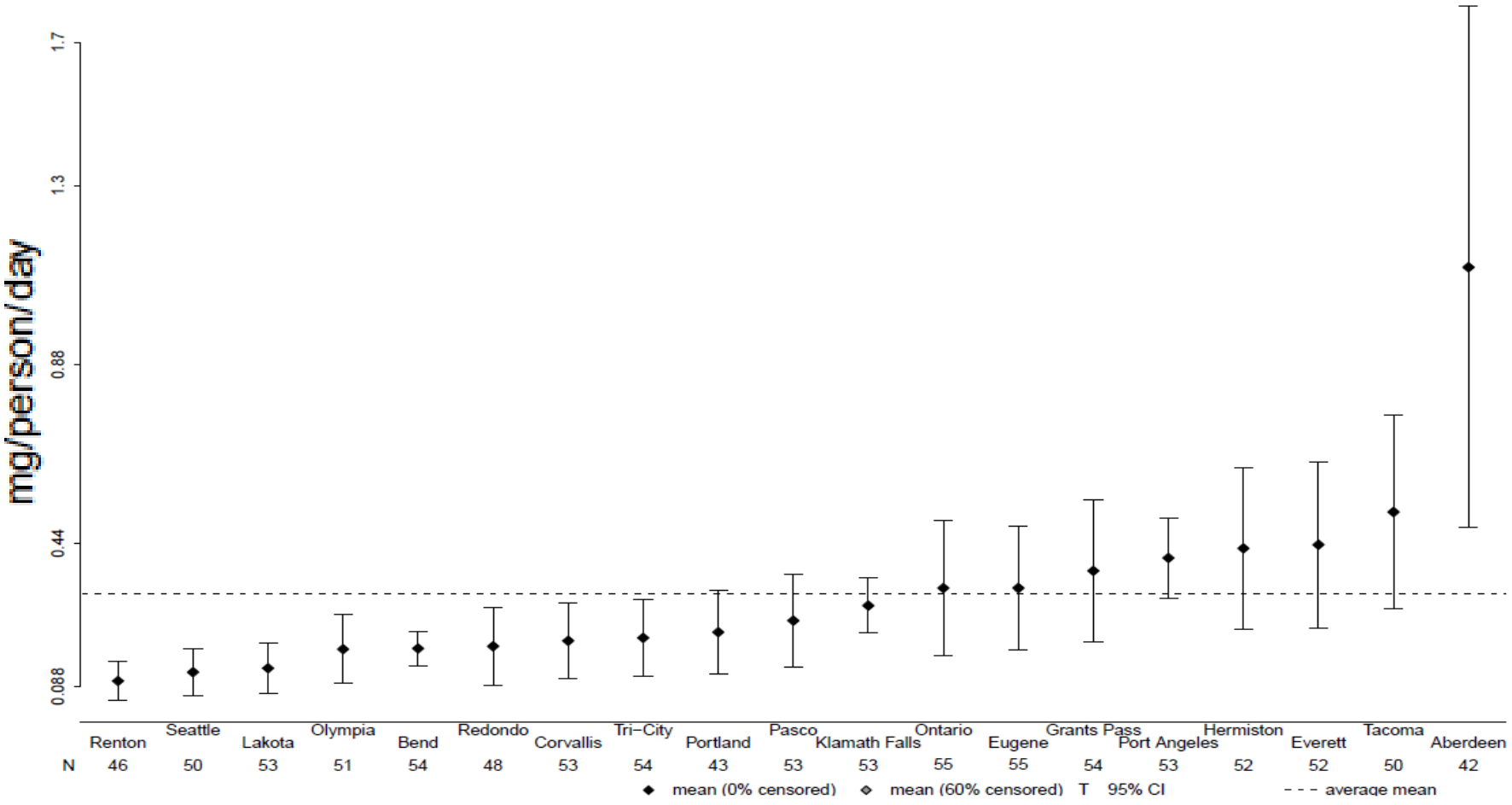
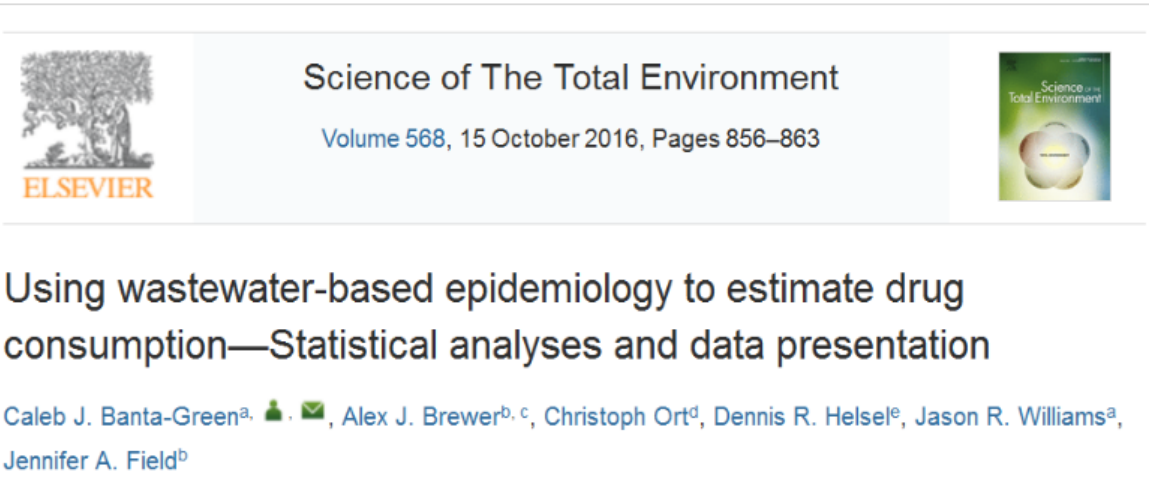


Figure 7: Methamphetamine index load (mg/person/day) mean with 95% confidence interval

Statistical Analyses

- Need to create:
  - Index load-estimated concentration of drug/metabolite, adjusting for sample preparation procedures, total wastewater flow, and population
  - Confidence bounds for estimate
- Address missing/censored data



ELSEVIER

Science of The Total Environment

Volume 568, 15 October 2016, Pages 856–863

Using wastewater-based epidemiology to estimate drug consumption—Statistical analyses and data presentation

Caleb J. Banta-Green[a], Alex J. Brewer[b, c], Christoph Ort[d], Dennis R. Helsel[e], Jason R. Williams[a], Jennifer A. Field[b]

Overview of Wastewater Testing for Drugs

Drug	Studies/findings	Challenges/issues
Illicit stimulants	Often detected	Sometimes below detection limits. Common drugs, deaths common.
Cannabis	Difficult to interpret	Very limited human metabolization data, in-sewer metabolization complicated.
Heroin	Difficult to detect and interpret	Degrades to nonspecific metabolites quickly. Seems ill-suited to wastewater testing.
Rx opioids	Most are easy to detect	High potency compounds, present at very low levels. Added value of wastewater testing?
Non-Rx opioids/ fentanyls	Very difficult to detect	Very low concentrations. Major public health concern, high lethality. Presence/absence important.

Considerations Going Forward

- What do we really want to know?
- Is a specific drug present:
  - In our city?
  - At a specific venue?
- Comparing trends across place or time?
- What are the characteristics of the drugs, users, and system?
- Can the real questions of interest be answered with wastewater testing?

For More Information

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  - calebbg@uw.edu

Panel Discussion

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University of Washington

Kevin Bisceglia
Hofstra University

Katrice Lippa
National Institute of Standards and Technology

Moira O'Brien
National Institute on Drug Abuse

IV. Knowledge gaps in treatment of opioid/substance abuse

Melinda Campopiano

Substance Abuse and Mental Health Services Administration

MATHEMATICA Policy Research

Substance Abuse and Mental Health Services Administration SAMHSA

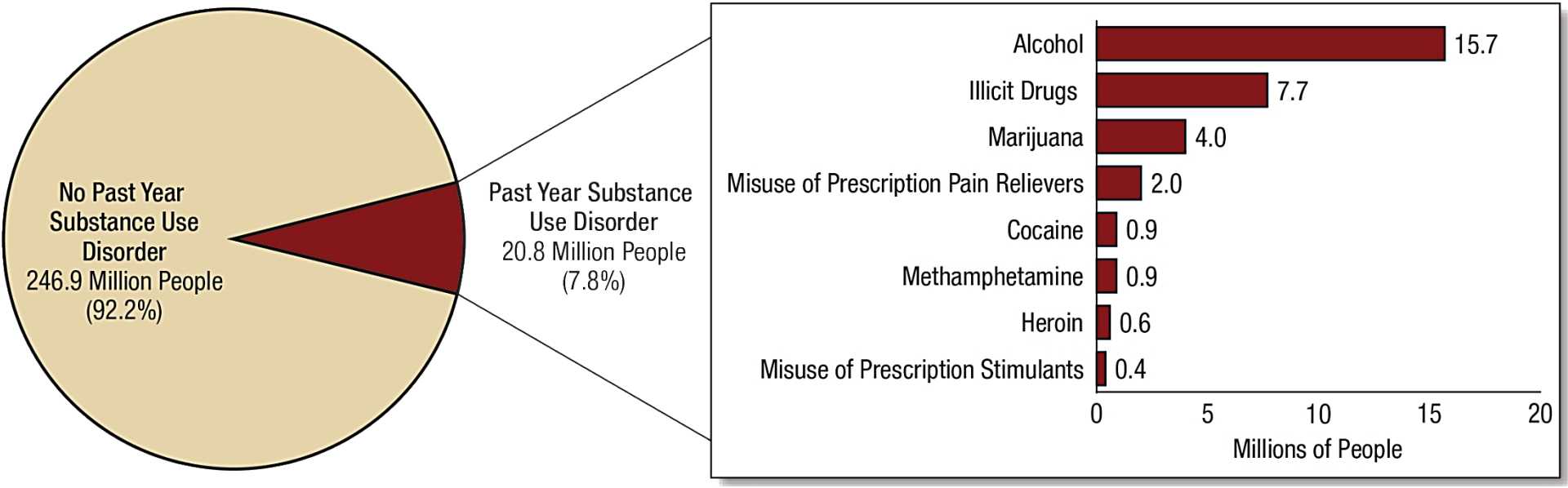
Knowledge Gaps in Treatment of Substance Use Disorder

Wastewater Symposium
Washington, DC

May 16, 2017

Melinda Campopiano, M.D.
SAMHSA/CSAT

Number of People Ages 12 or Older with a Past-Year Substance Use Disorder: 2015 National Survey on Drug Use and Health (NSDUH)



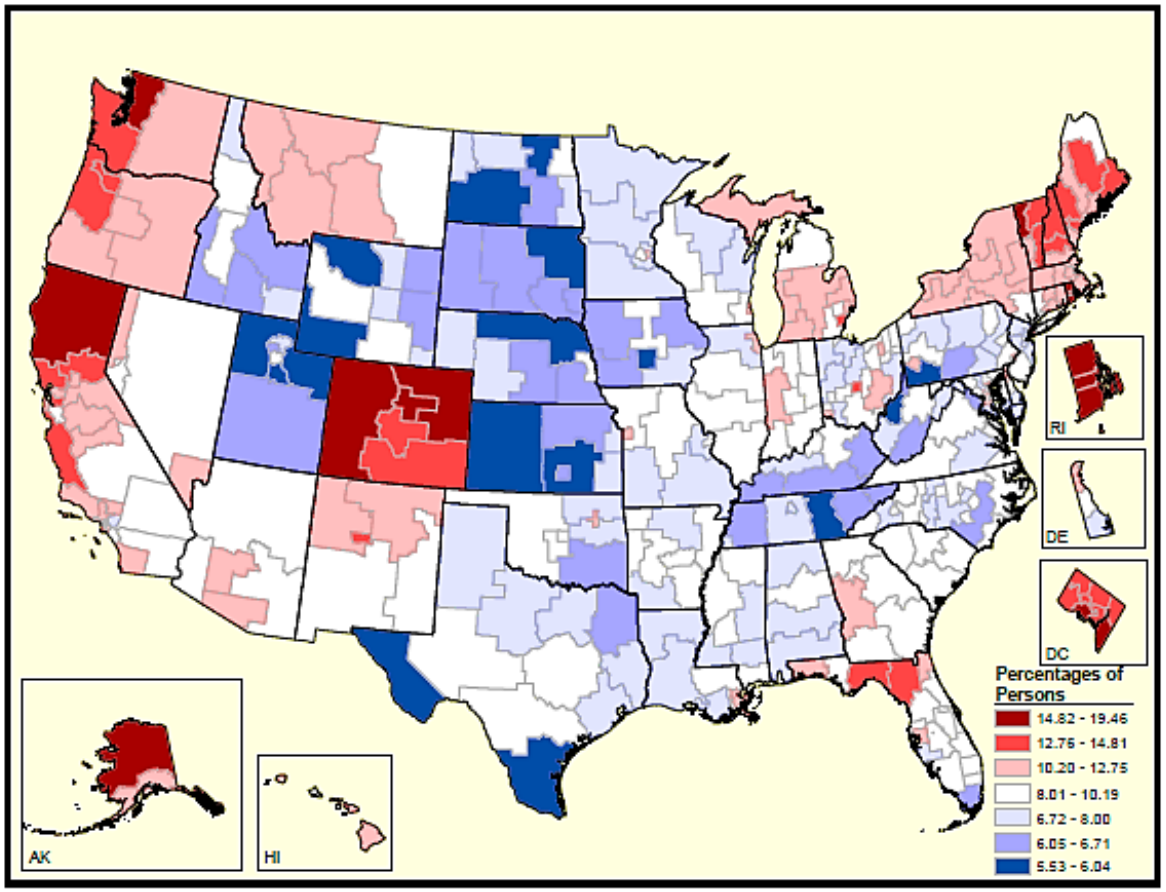
Notes:

The estimated numbers of people are people ages 12 or older in the civilian, noninstitutionalized population in the United States. The numbers do not sum to the total population of the United States because the population for NSDUH does not include people ages 11 or younger, people with no fixed household address (such as homeless or transient people not in shelters), active-duty military personnel, and residents of institutional group quarters (such as correctional facilities, nursing homes, mental institutions, and long-term care hospitals).

The estimated numbers of people with substance use disorders are not mutually exclusive because people could have use disorders for more than one substance.

Substate Reports: Illicit Drug Use in Past Month

Figure 1 *Illicit Drug Use in the Past Month* **among Individuals Aged 12 or Older, by Substate Region: Percentages, Annual Averages Based on 2012, 2013, and 2014 NSDUHs**

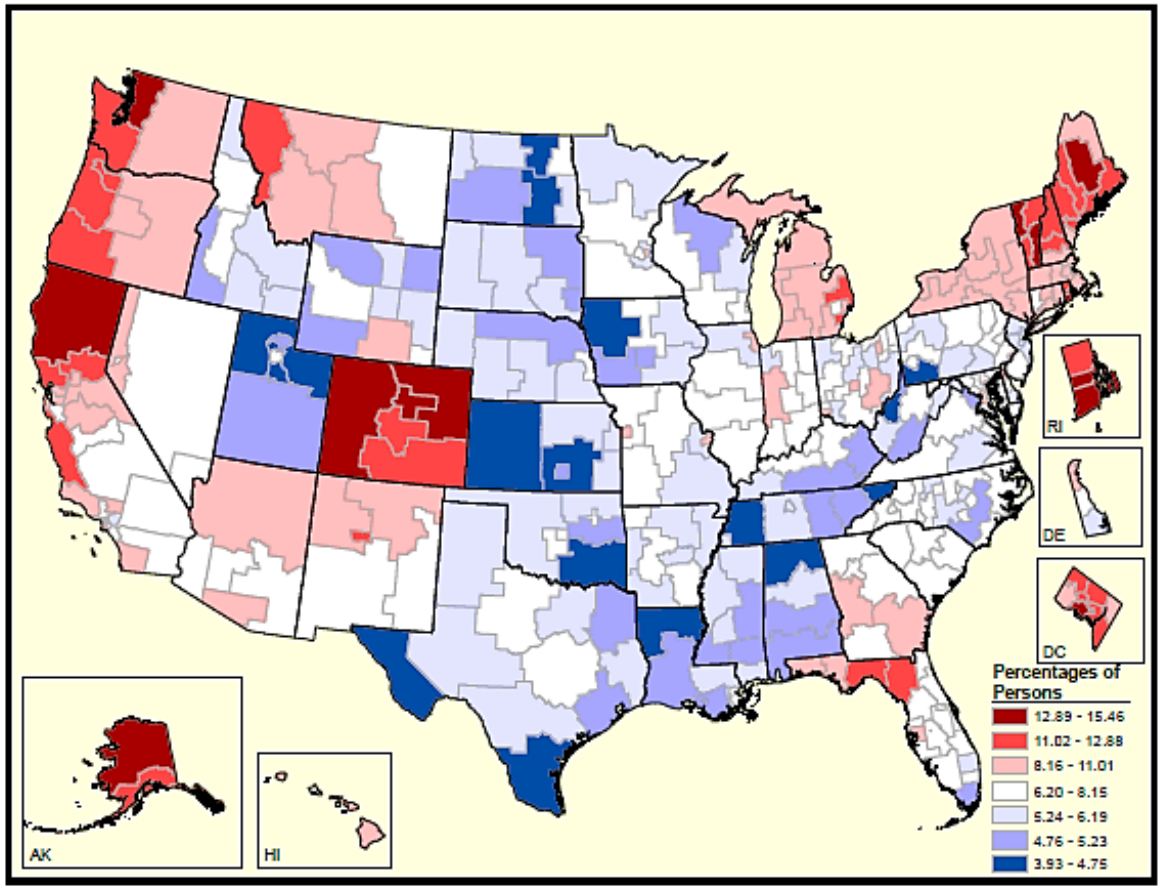


NOTE: For substate region definitions, see the "2012-2014 National Survey on Drug Use and Health Substate Region Definitions" at http://www.samhsa.gov/data/.

Source: SAMHSA, Center for Behavioral Health Statistics and Quality, National Survey on Drug Use and Health, 2012, 2013, and 2014.

Substate Reports: Marijuana Use in Past Month

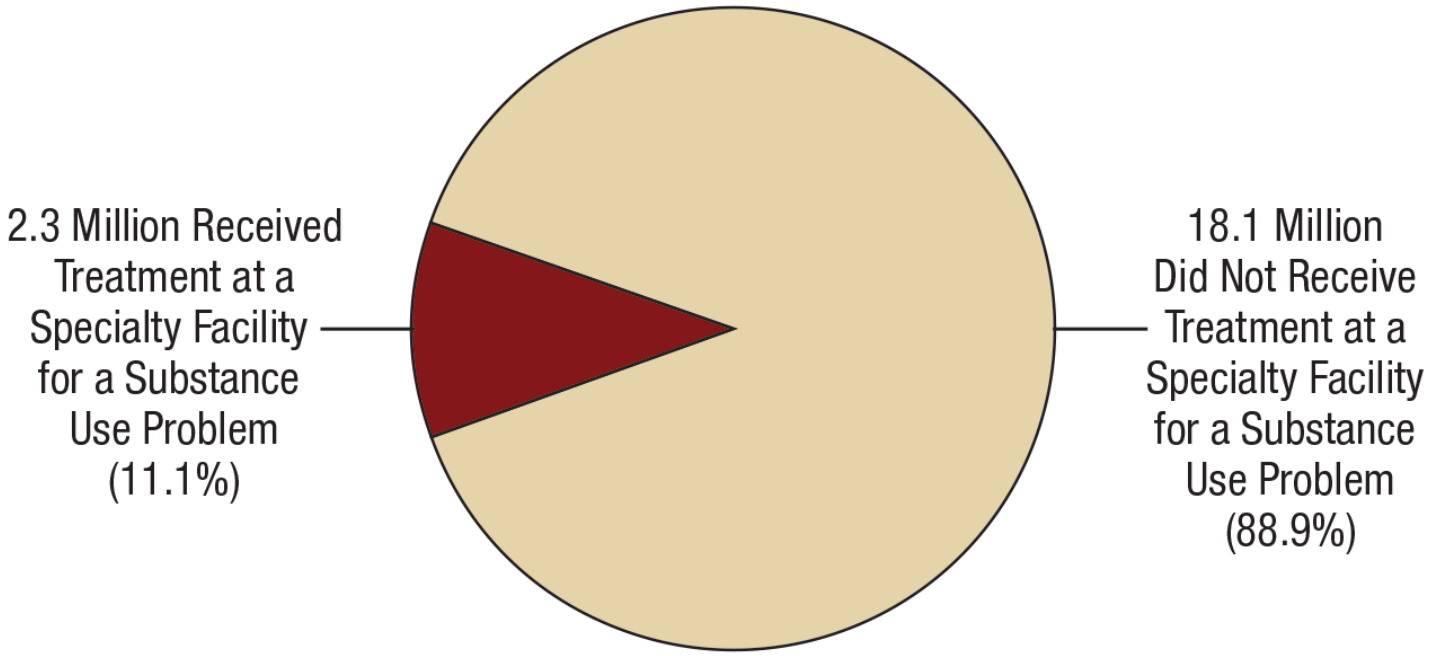
Figure 3 ***Marijuana Use in the Past Month*** **among Individuals Aged 12 or Older, by Substate Region: Percentages, Annual Averages Based on 2012, 2013, and 2014 NSDUHs**



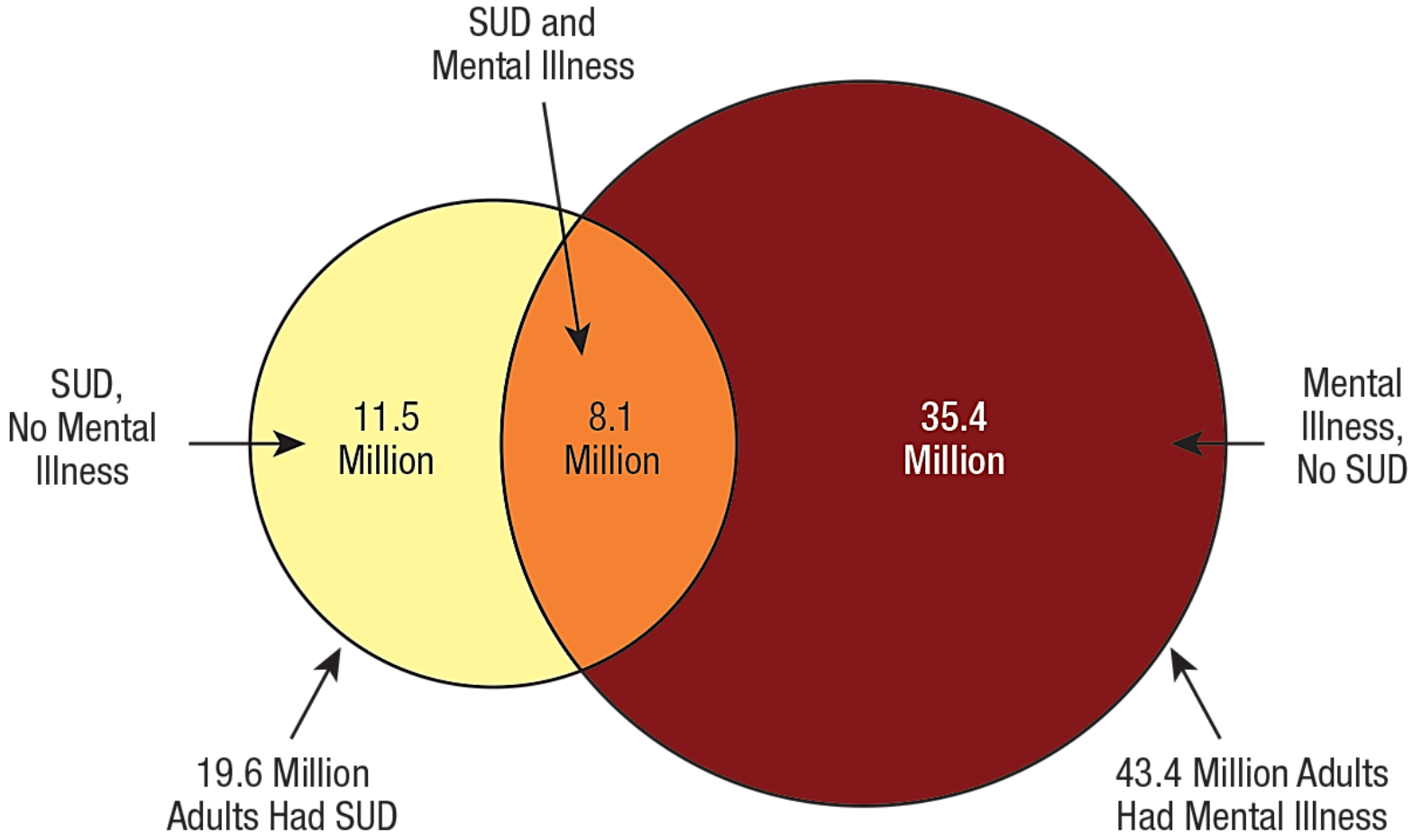
NOTE: For substate region definitions, see the "2012-2014 National Survey on Drug Use and Health Substate Region Definitions" at http://www.samhsa.gov/data/.

Source: SAMHSA, Center for Behavioral Health Statistics and Quality, National Survey on Drug Use and Health, 2012, 2013, and 2014.

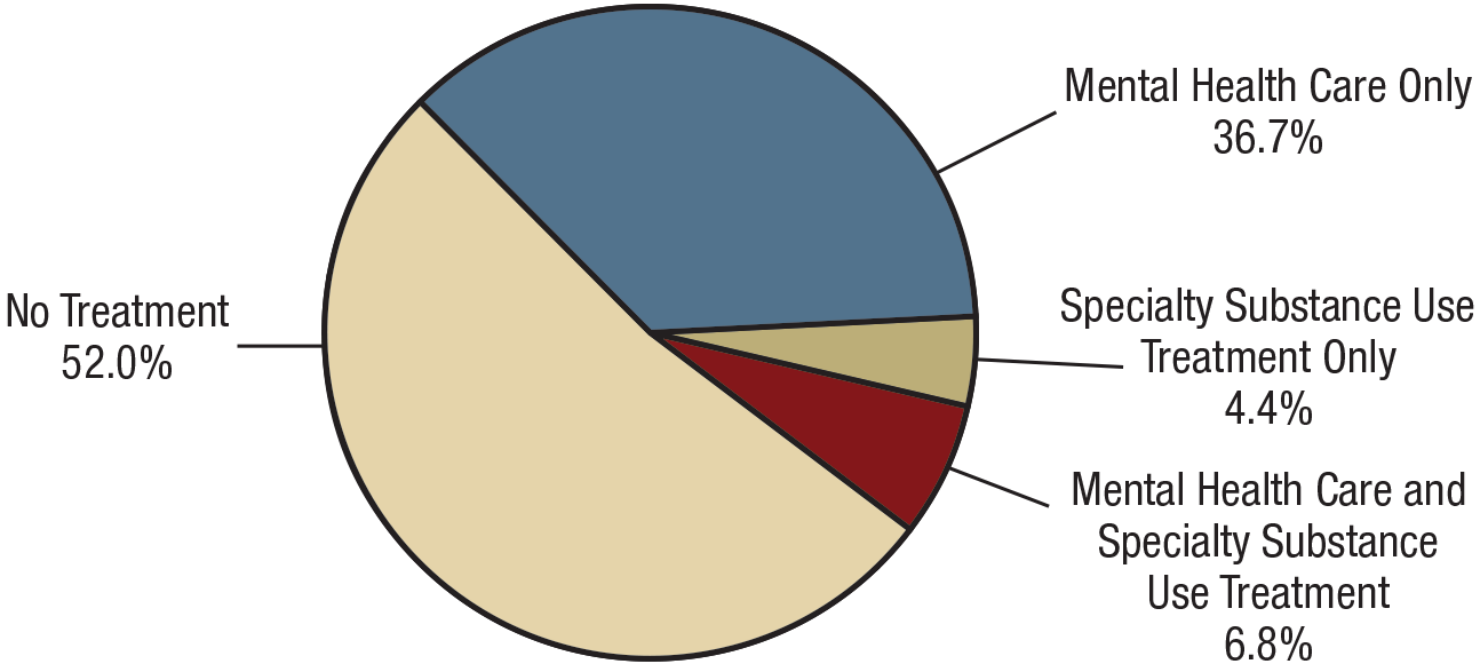
Receipt of Specialty Treatment in the Past Year Among Adults Age 18 or Older Who Needed Substance Use Treatment in the Past Year: 2015 NSDUH



Past-Year Substance Use Disorder (SUD) and Mental Illness (MI) Among Adults Age 18 or Older: 2015 NSDUH



Receipt of Mental Health Care and Specialty Substance Use Treatment in Past Year Among Adults Age 18 or Older Who Had Past-Year MI and SUD: Percentages, 2015 NSDUH



8.1 Million Adults with Co-Occurring Mental Illness and Substance Use Disorders

Notes:

Mental health care is defined as having received inpatient care or outpatient care or having used prescription medication for problems with emotions, nerves, or mental health. Specialty substance use treatment refers to treatment at a hospital (inpatient only), rehabilitation facility (inpatient or outpatient), or mental health center to reduce or stop drug or alcohol use or for medical problems associated with drug or alcohol use.

The percentages do not add to 100% due to rounding.

Treatment (1)

- What type of treatment is being provided, and where?
- How are medications and psychosocial services being provided, together and/or separately?

Treatment (2)

- What role does stigma play among providers, the public, and patients—broadly and for specific types of treatments?
- How does implementation of evidence-based treatment vary across communities?

Actual Use

- What drugs are being used, and how does this vary across communities?
- Does depersonalized information about substance use in a community increase or decrease prejudice and misinformation?

Public Health and Safety

- Is it possible to find out when new synthetic substances become available in a community so we can warn the public and educate potential users to reduce morbidity and mortality?

Thank you!

- Melinda Campopiano
  - Melinda.Campopiano@samhsa.hhs.gov

Panel Discussion

Melinda Campopiano
Substance Abuse and Mental Health Services Administration

Renee Johnson
Johns Hopkins University

Aleksandra Zgierska
American Society of Addiction Medicine

V. Successes and hurdles in international wastewater testing efforts

Jochen Mueller

University of Queensland

Introduction to Wastewater-Based Epidemiology

- Click here to watch a short video introducing wastewater-based epidemiology

MATHEMATICA Policy Research

THE UNIVERSITY OF QUEENSLAND AUSTRALIA

score

Successes and Hurdles in International Wastewater Testing

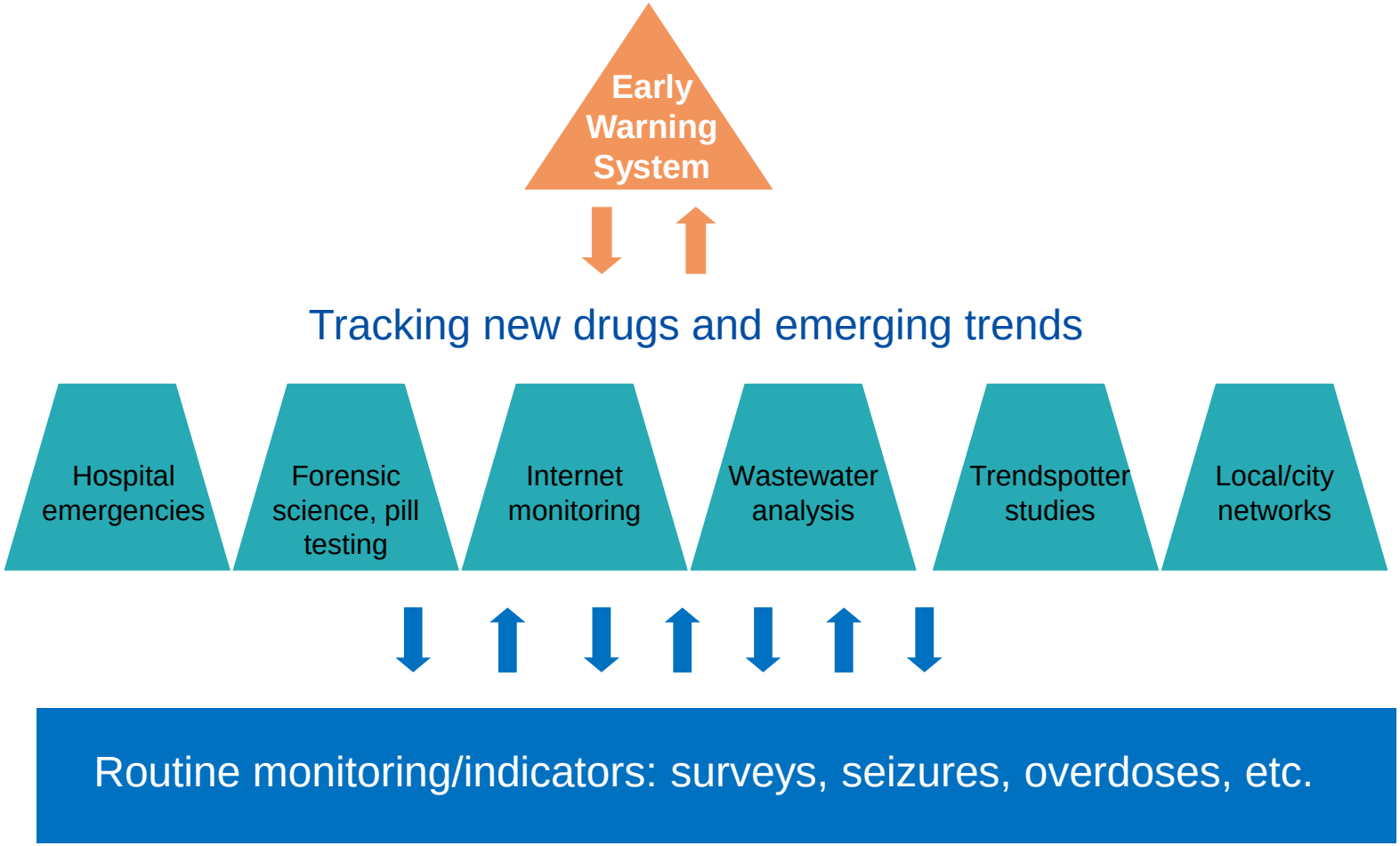
Wastewater Symposium
Washington, DC

May 16, 2017

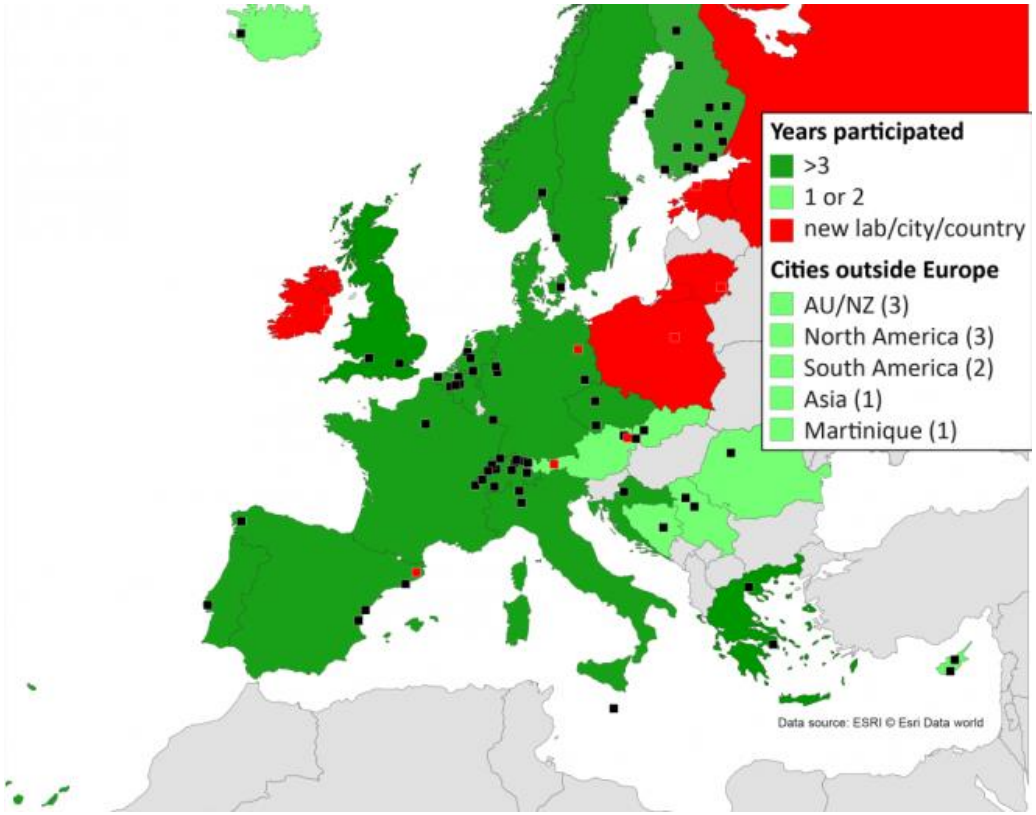
Jochen Mueller • Sara Castiglioni • Liesbeth Vandam • Kevin Thomas

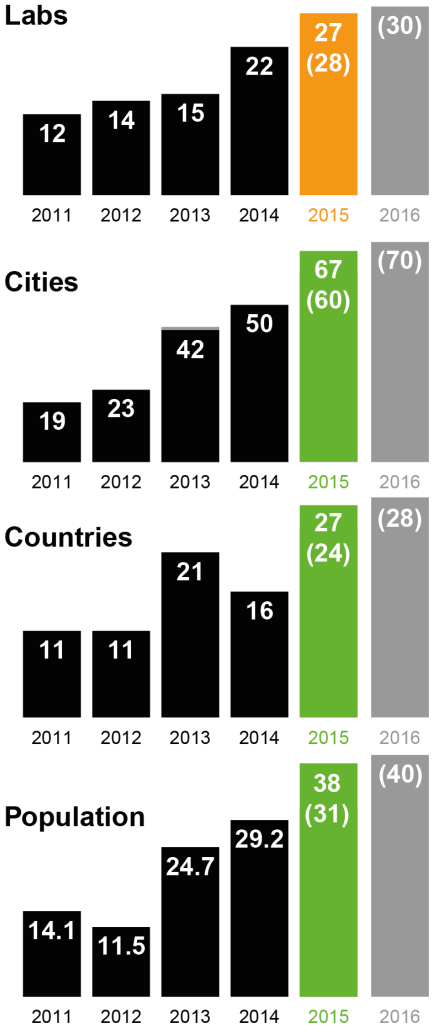
On behalf of Sewage Analysis CORe group Europe (SCORE), the Australian National Wastewater Drug Monitoring Program, and related programs conducted by presenters

Monitoring in the EU: A Multisource Approach



SCORE as a Data Provider

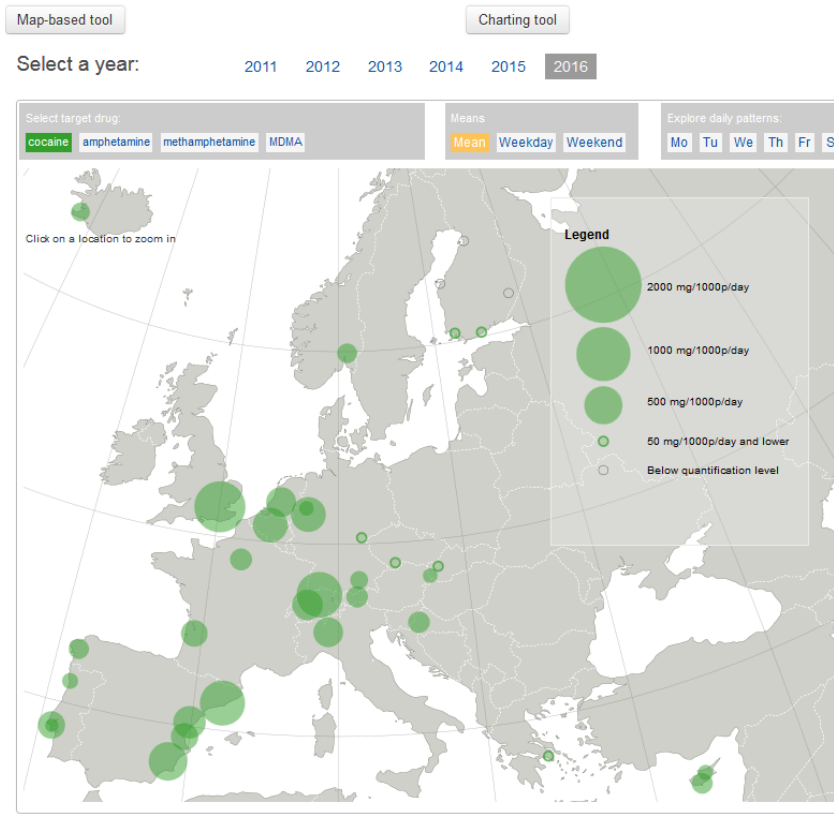


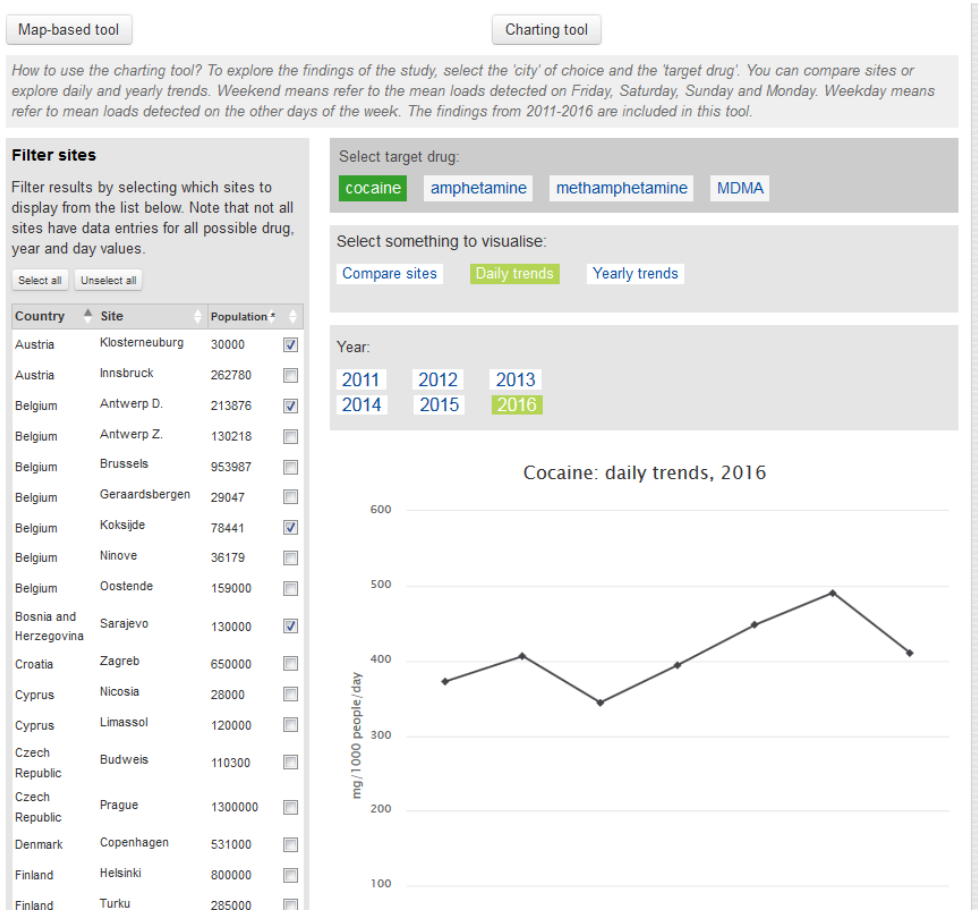


European Monitoring Centre for Drugs and Drug Addiction

The Potential of Wastewater Testing for Public Health and Safety

EMCDDA Publication of Wastewater Findings



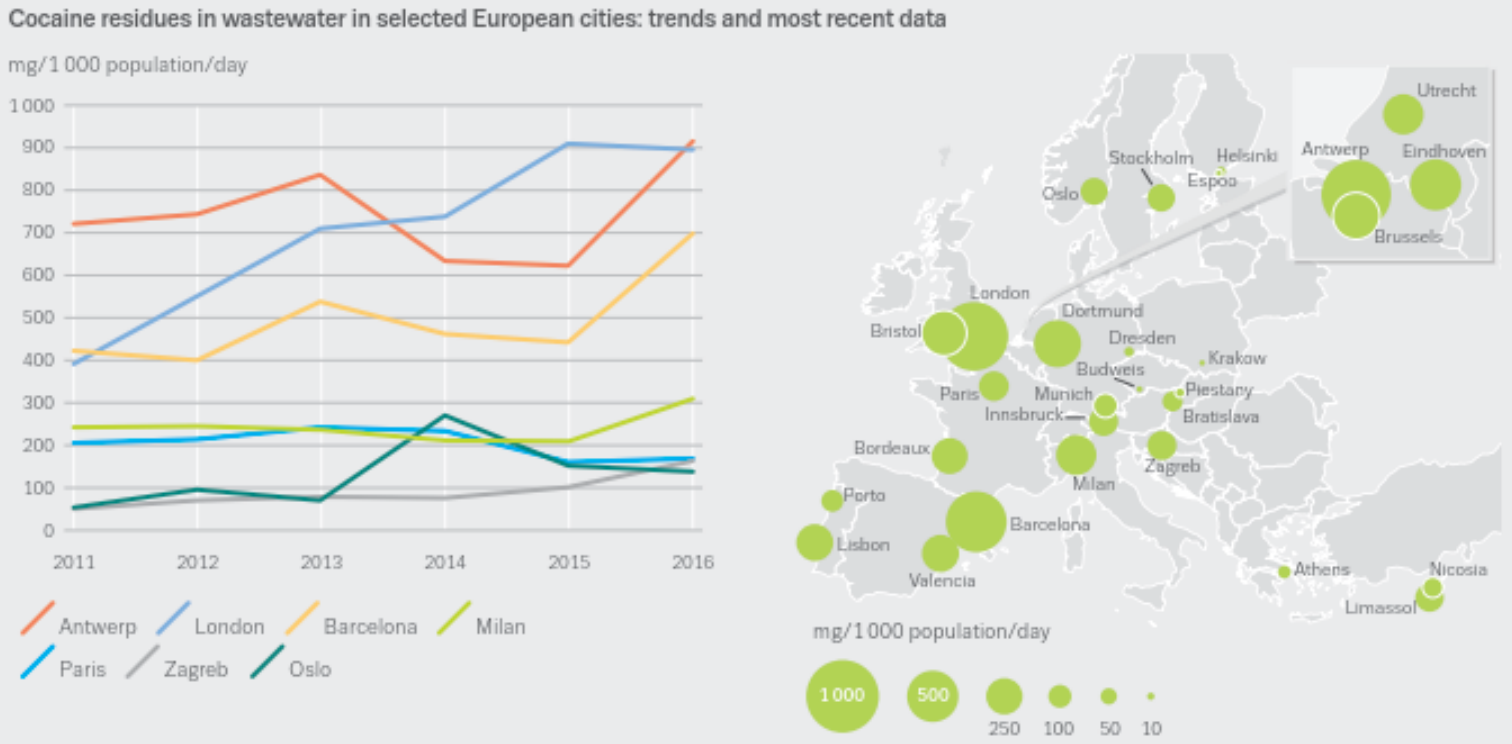


European Monitoring Centre for Drugs and Drug Addiction

EMCDDA = European Monitoring Centre for Drugs and Drug Addiction

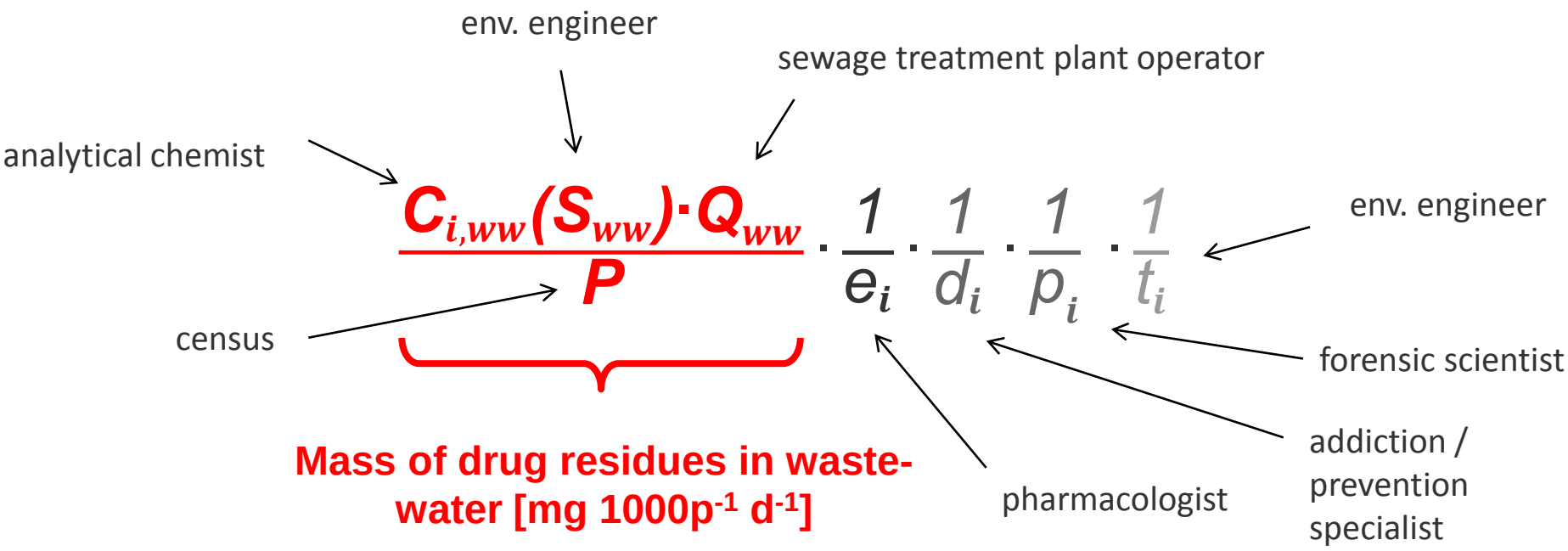
The Potential of Wastewater Testing for Public Health and Safety

Cocaine Findings, 2016



NB: Mean daily amounts of benzoylecgonine in milligrams per 1 000 population. Sampling was carried out in selected European cities over a week in 2016.
Source: Sewage Analysis Core Group Europe (SCORE).

The Fundamentals…Simplified (1)



$C_i(S_{ww})$: concentration in a sample
Q_{ww}: sample volume
P: population
e_i: excretion
d & p: dose and purity
t_i: loss in sewer (transformation and sorption)

The Fundamentals…Simplified (2)

Population-normalized drug consumed (M) estimated from:

$$M_i = \frac{C_{i,ww} \cdot Q_{ww}}{Population} \cdot CorrFac_i \quad \text{in} \quad \frac{g}{day \cdot person}$$

Mi: mass load of chemical normalized to sampling period (day) and population

Ci(Sww): concentration in a sample; a function of concentration and analytical method

Qww: sampling; the smaller the catchment, the greater the sampling requirements; potential issue with sampling of hydrophobic chemicals

P: population; modelled from other markers; uncertainty in spatial > temporal trends

CorrFac: excretion, loss in sewer, and other factors

Uncertainties—Methamphetamine in Australia

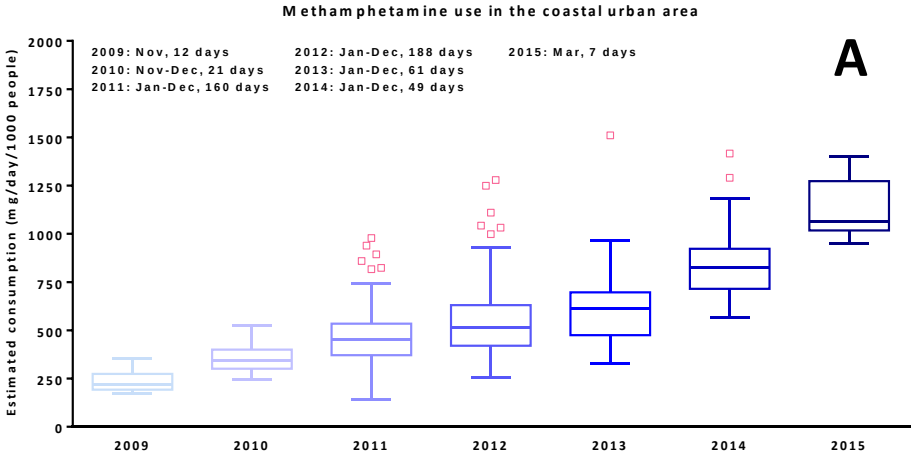
- Trend observable
- Uncertainties relatively small
- Trend probably too big to explain by increase in purity/dose
- Trend holds across populations

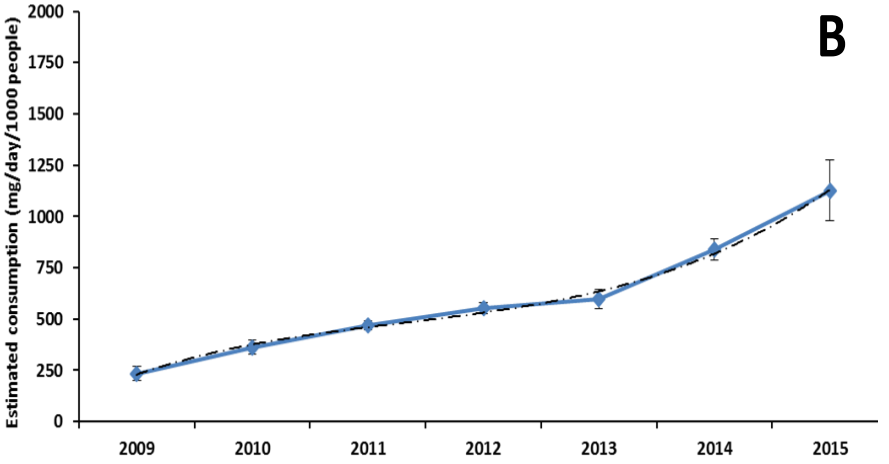
National ICE Taskforce

➔ **Recommends wastewater analysis**

➔ **Control the ICE "epidemic"**

Wastewater analysis—accurate and reliable for Methamphetamine





The Potential of Wastewater Testing for Public Health and Safety

Some Opioids Targeted by Wastewater Analysis

Common Opioids	Metabolite/target
Codeine	Codeine Norcodeine Codeine-6-glucuronide **Morphine**
Fentanyl	Fentanyl Norfentanyl
Ketamine	Ketamine Norketamine
Methadone	Methadone EDDP
Morphine	**Morphine** Morphine-glucuronide
Oxycodone	Oxycodone Noroxycodone Oxymorphone
Heroin (diacetylmorphine)	6-monoacetylmorphine (6-MAM) **Morphine**

Other opioids	Metabolite/target
Ketamine	Ketamine Norketamine
Buprenorphine	Buprenorphine Norbuprenorphine
Hydrocodone	Hydrocodone Norhydrocodone
Hydromorphone	Hydromorphone Hydromorphone-glucuronide
Oxymorphone	Oxymorphone Oxymorphone-glucuronide

Heroin Temporal Trends in Italy, EU

17 cities

Drug and Alcohol Dependence 161 (2016) 178–188

Contents lists available at ScienceDirect

Drug and Alcohol Dependence

journal homepage: www.elsevier.com/locate/drugalcdep

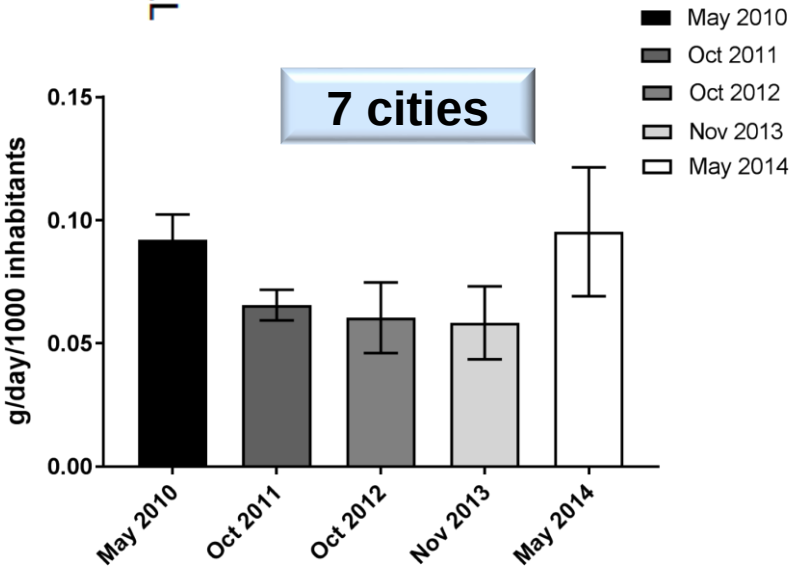
Full length article

Population surveys compared with wastewater analysis for monitoring illicit drug consumption in Italy in 2010–2014

Ettore Zuccato[a,*], Sara Castiglioni[a], Ivan Senta[b], Andrea Borsotti[a], Bruno Genetti[c], Alessandra Andreotti[c], Giovanni Pieretti[d], Giovanni Serpelloni[e,1]

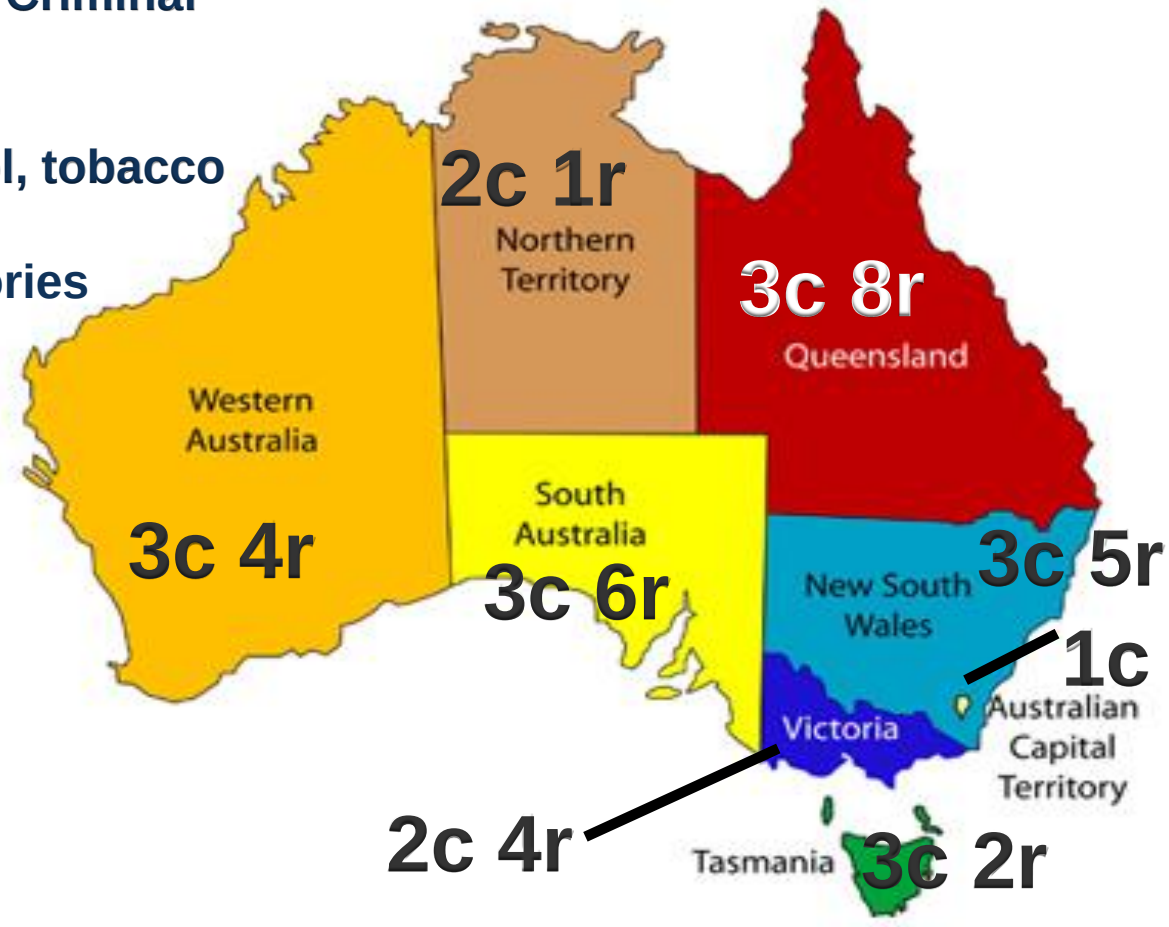
[a] Department of Environmental Health Sciences, IRCCS Istituto di Ricerche Farmacologiche Mario Negri, Via G. La Masa 19, 20156 Milan, Italy
[b] Rudjer Boskovic Institute, Division for Marine and Environmental Research, Bijenicka c. 54, 10000 Zagreb, Croatia
[c] Explora, Ricerca e Analisi Statistica. Via Ca' Pisani, Vigodarzere, 7-35010 Padua, Italy
[d] Dipartimento di Sociologia e Diritto dell'Economia, Università di Bologna, Bologna, Italy
[e] Former of the Department for Antidrug Policies, Presidency of the Council of Ministers, Rome, Italy

7 cities



Australian National Wastewater Drug Monitoring Program

- **Funded by the Australian Criminal Intelligence Commission**
- **Study illicit drugs, alcohol, tobacco**
- **Supported by state/territories**

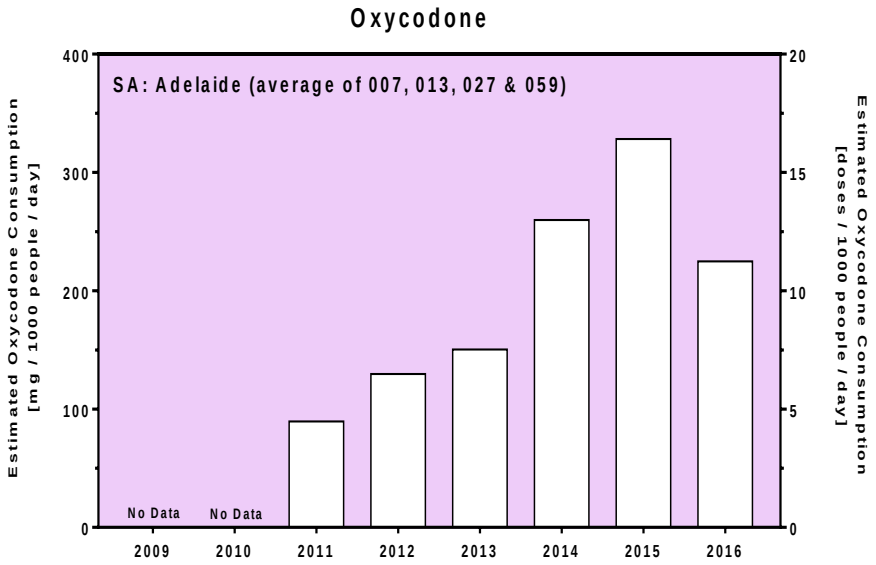


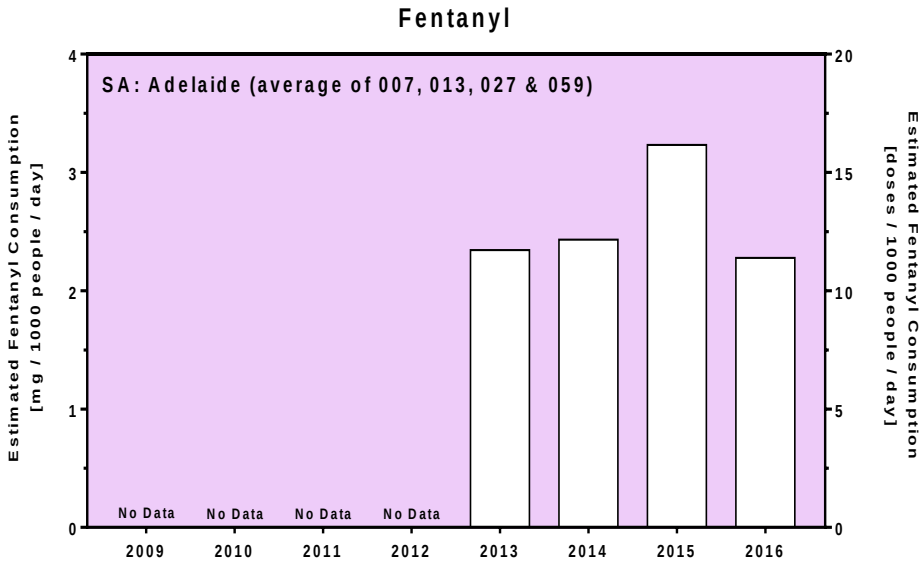
LEGEND

C = capital city wastewater treatment plant (WWTP); bimonthly sampling

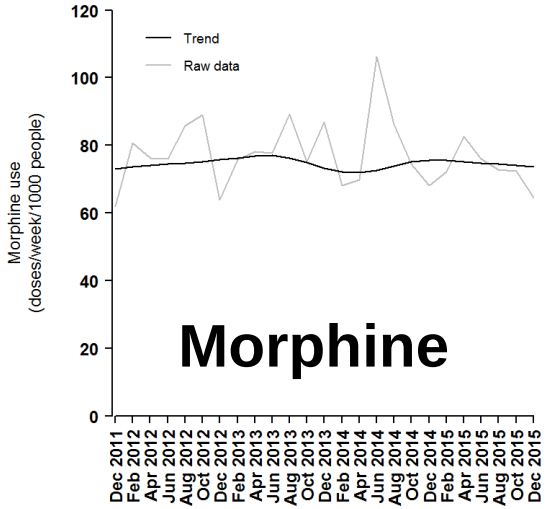
r = regional WWTP; quarterly sampling

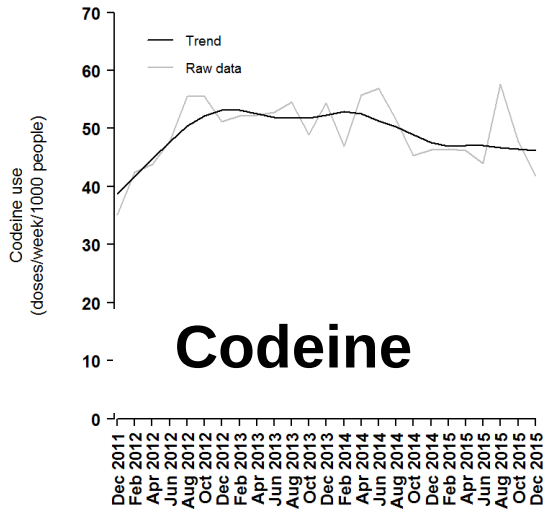
Opioid Trends in Adelaide, Australia

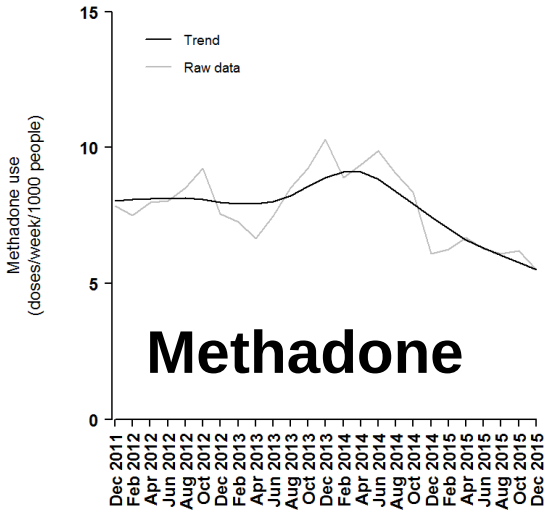


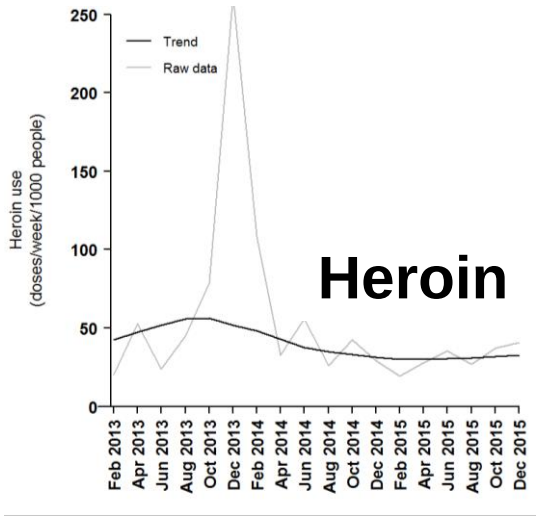


Estimated Opioid Use in Adelaide (2011–2015)



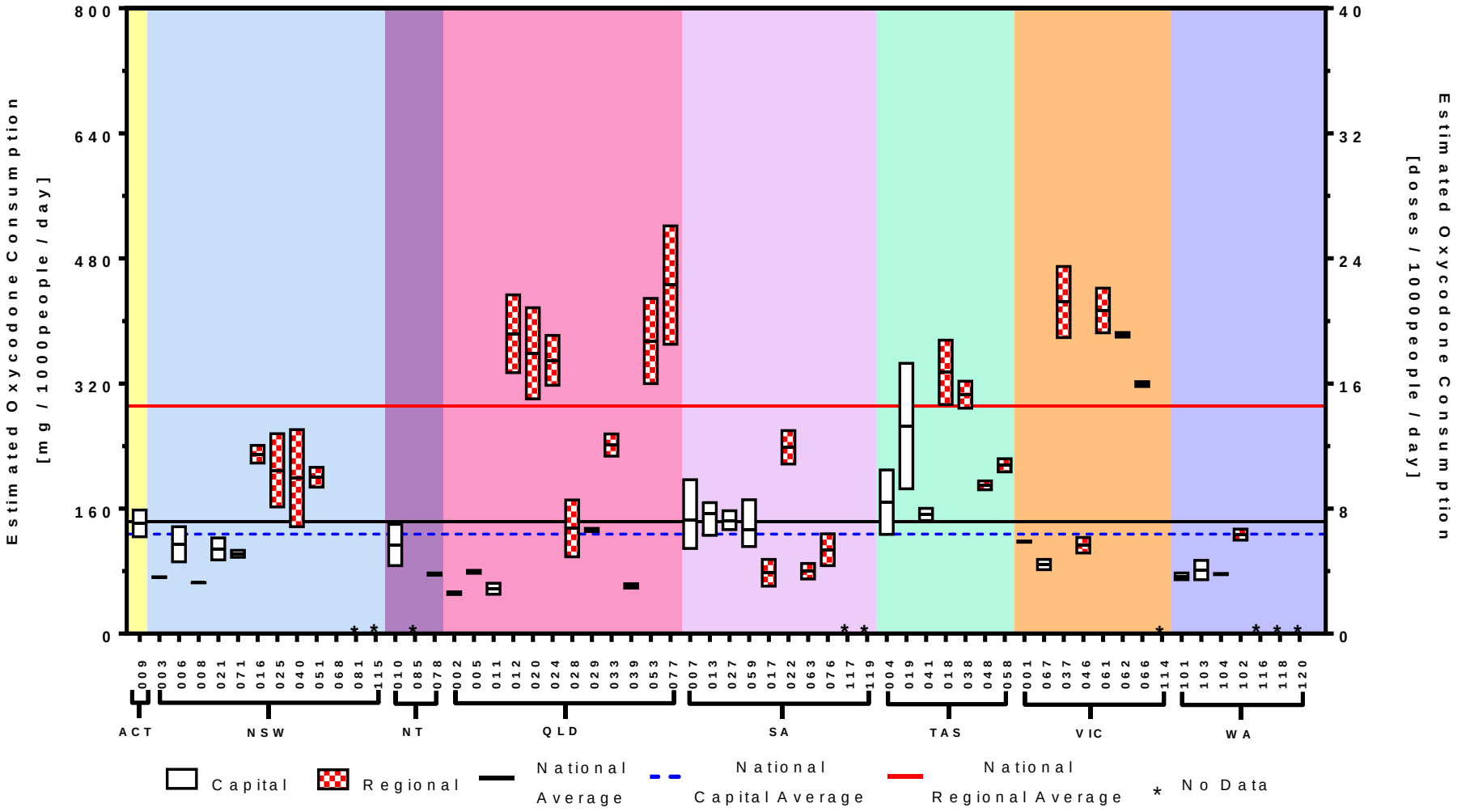






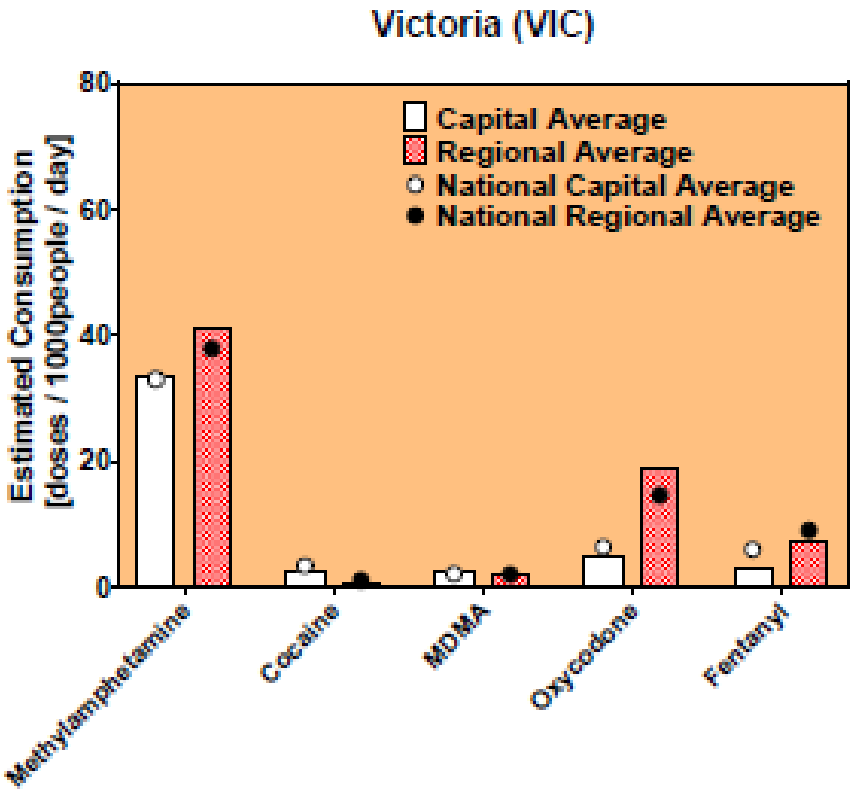
Tscharke et al. 2016 (STOTEN)

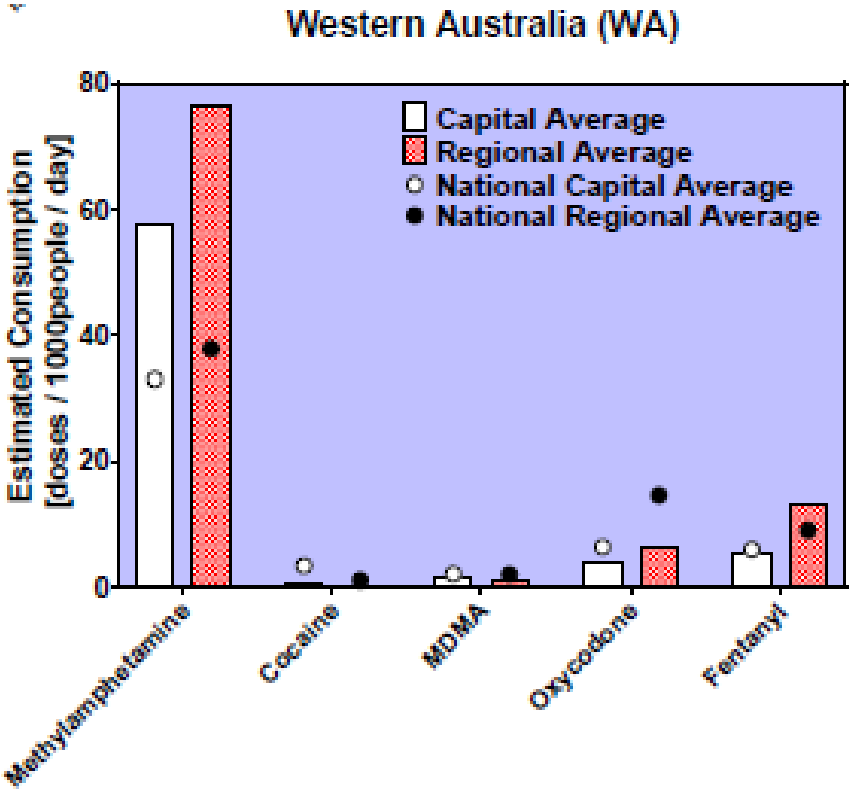
Spatial Trends of Oxycodone Use in Australia



The Potential of Wastewater Testing for Public Health and Safety

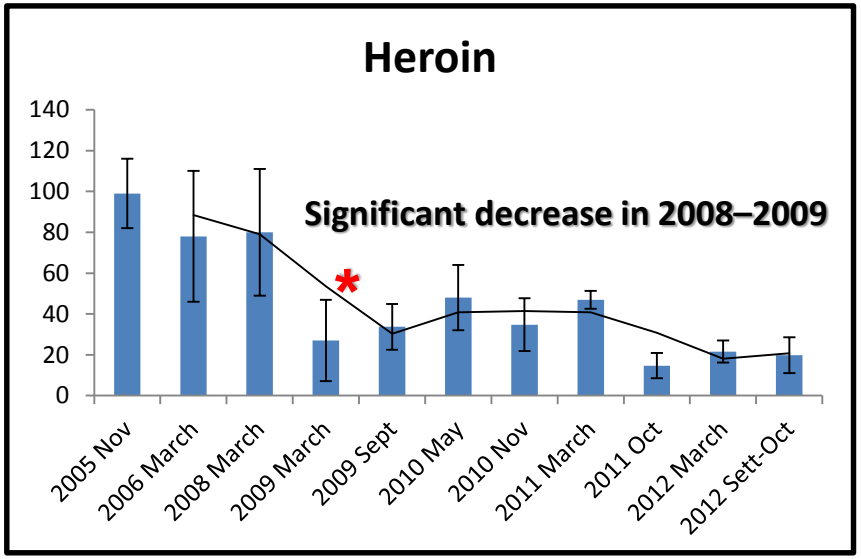
Attempting to Compare Use of Different Drugs





Comparison with Other Data Sources

Trends in Milan, Italy, 2005–2011, from wastewater-based epidemiology



Zuccato et al. (2011)

Epidemiological data—general population survey

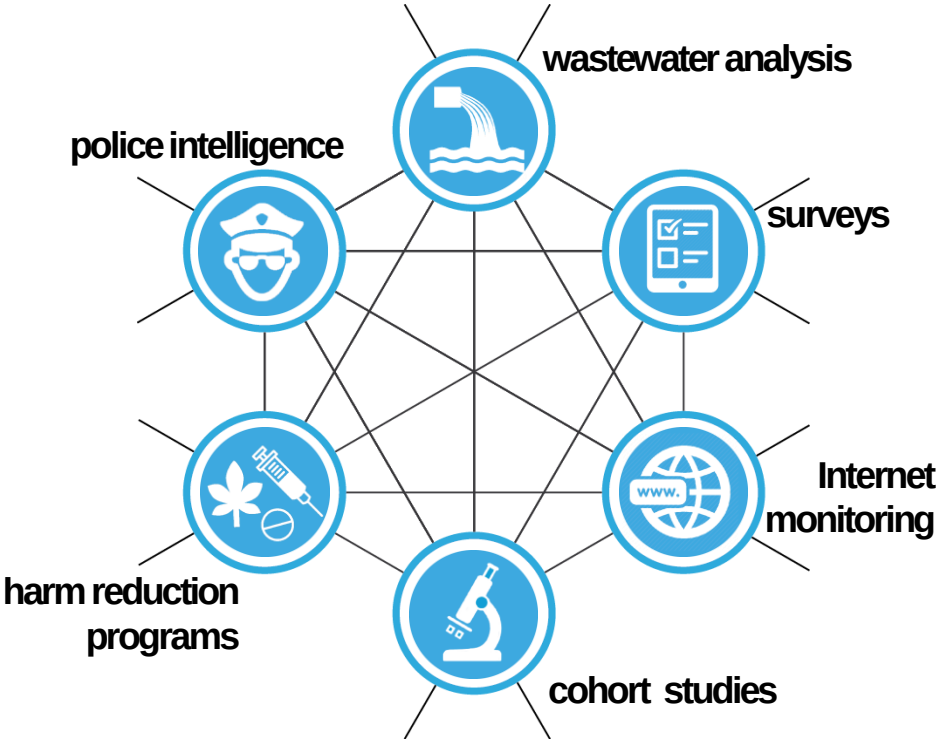
PRESIDENZA DEL CONSIGLIO DEI MINISTRI
Dipartimento Politiche Antidroga

Data reported in the Annual National Report in 2010

Sostanze	2008	2009	Differenza	Scostamento % (Δ%)
Eroina	0,39	0,25	-0,14	-35,9

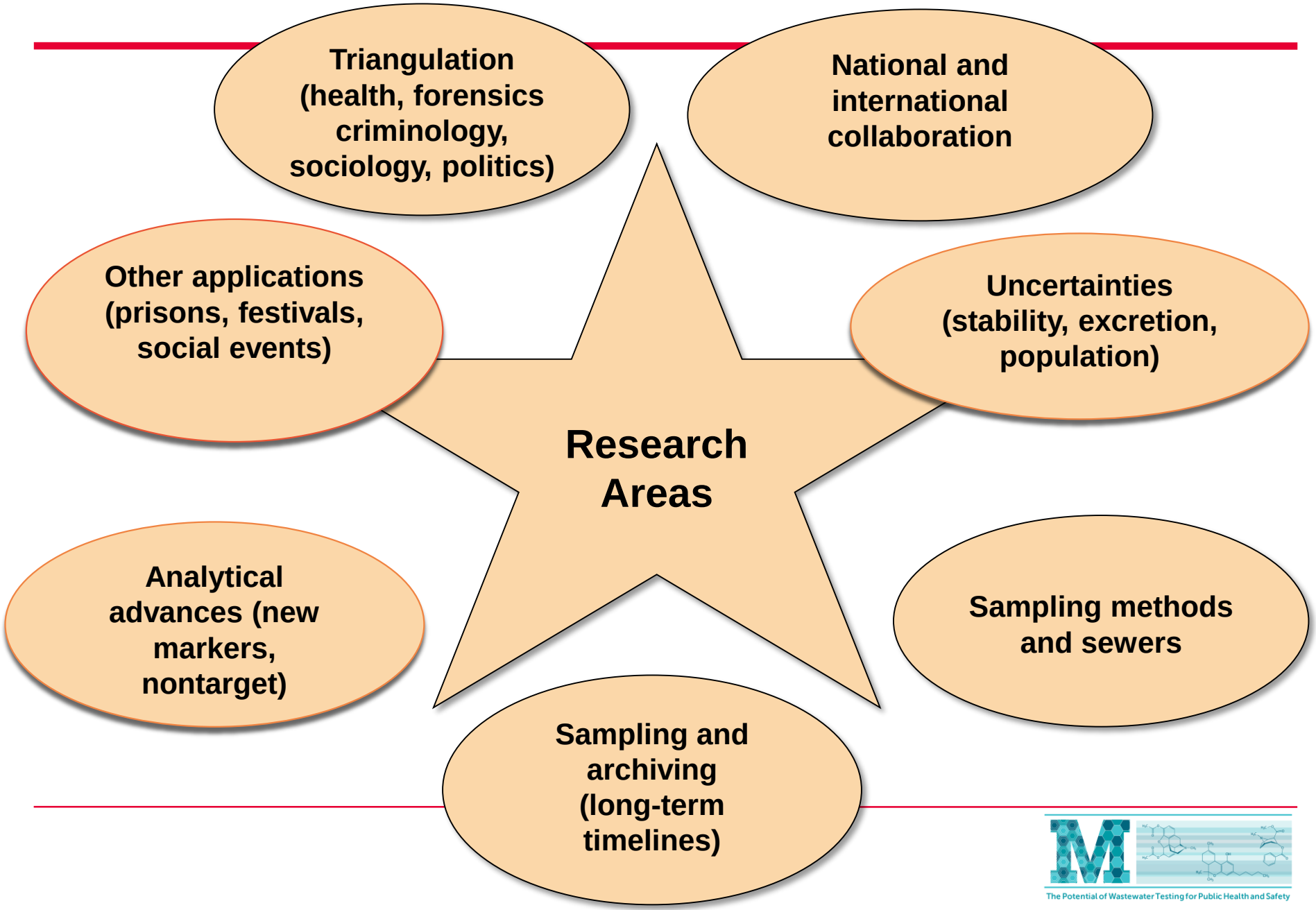
Similar decrease of heroin consumption from 2008 to 2009!

Triangulation of Drug Use



- Provide alternative perspectives to evaluate estimates
- Help target/identify new harms
  - What to look for in wastewater
- Include data about consumption habits/frequency
  - Use wastewater data to estimate number of users per type (occasional, regular, etc.)
- Intelligence about drug trafficking and criminal organizations
  - Estimate market size and/or share held by specific criminal organisations

Where to...?


Triangulation (health, forensics criminology, sociology, politics)
National and international collaboration
Other applications (prisons, festivals, social events)
Uncertainties (stability, excretion, population)
Research Areas
Analytical advances (new markers, nontarget)
Sampling methods and sewers
Sampling and archiving (long-term timelines)

Summary and Conclusion

- Wastewater analysis is now routinely used to monitor a wide range of drugs
- Routine programs in Europe and Australia include monitoring of trends of selected opioids
- Uncertainties exist with assessing use of various opioids

For More Information

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- Liesbeth Vandam
  - Liesbeth.Vandam@emcdda.europa.eu

Panel Discussion

Jochen Mueller
The University of Queensland

Sara Castiglioni
Mario Negri Institute for Pharmacological Research

Frederic Been
University of Antwerp

Liesbeth Vandam
European Monitoring Centre for Drugs and Drug Addiction

Audience Q&A

If we think about how to translate the European monitoring system to the U.S., at what level should coordination begin?

- **A) City/Town level**
- **B) Regional level**
- **C) State level**
- **D) National level**
- **E) All of the above**

VI. Keynote Speaker

J.B. Wogan

Governing Magazine

VII. Knowledge gaps in prevention of opioid and other substance abuse

Jeffrey Locke

National Governors Association

MATHEMATICA Policy Research

NGA NATIONAL GOVERNORS ASSOCIATION

How Governors and States Are Approaching the Opioid Epidemic

Wastewater Symposium
Washington, DC

May 16, 2017

Jeffrey Locke
National Governors Association (NGA)

Road Map to the Presentation

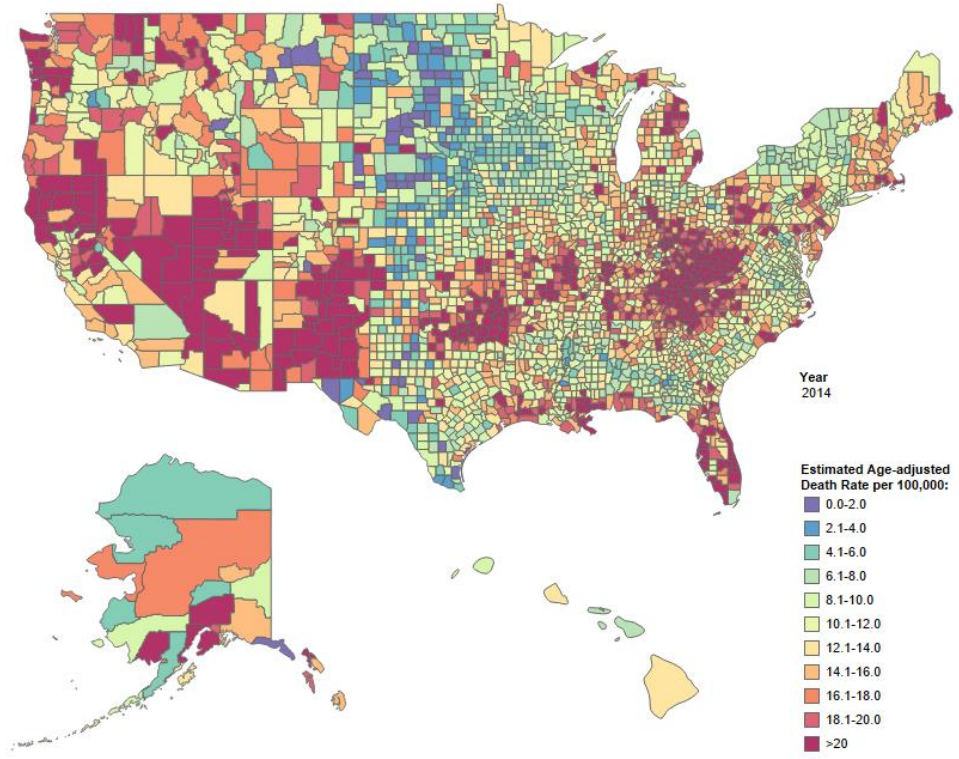
- NGA background
- Snapshot of the problem
- Challenges facing governors
- State efforts and progress
- Selected state strategies and trends

About the National Governors Association

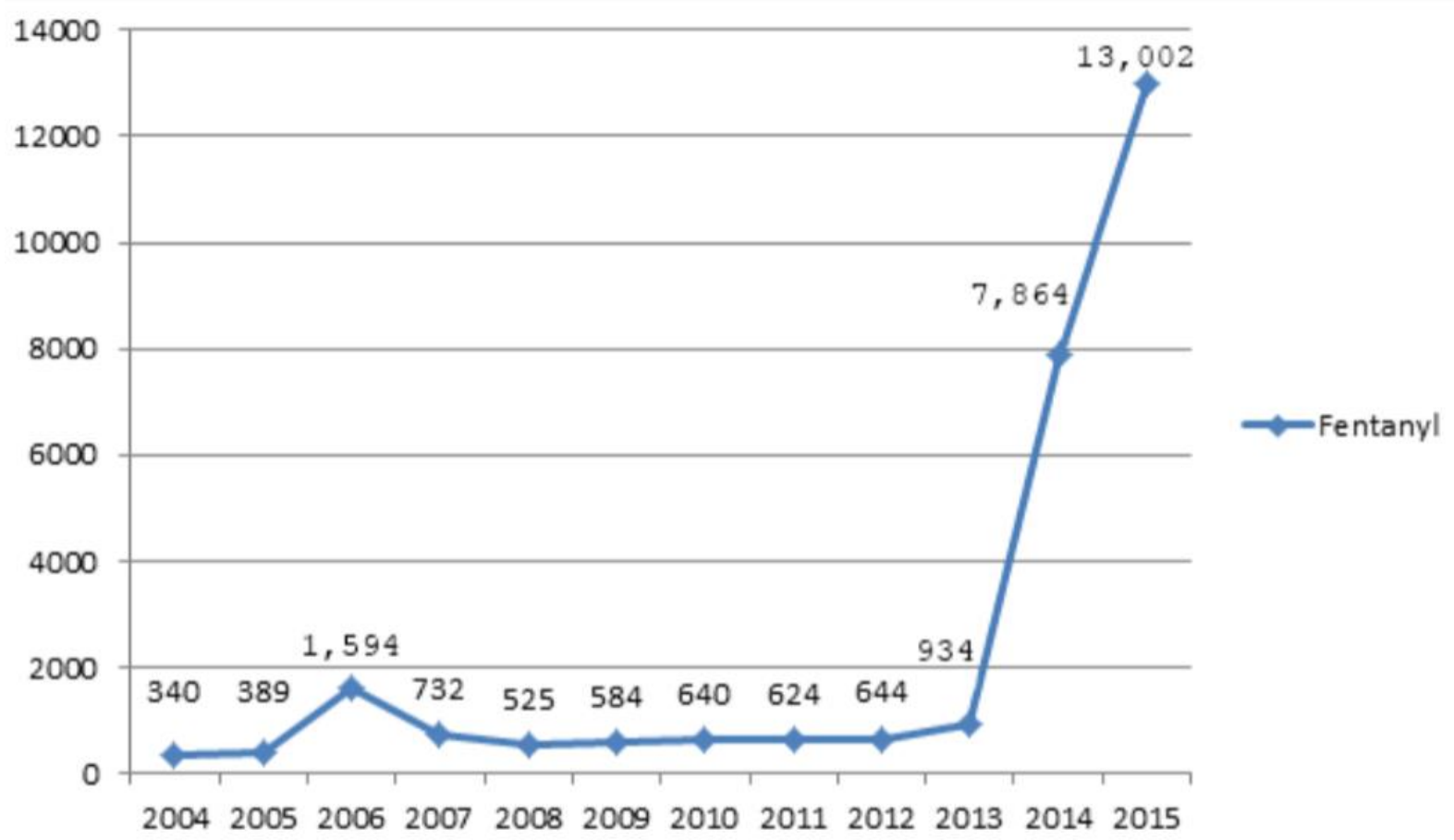
Conference of Governors
The White House, 1908

Opioid Deaths by State, 1999–2014

2014 RAPID INCREASE IN RATES OF DRUG OVERDOSE DEATHS



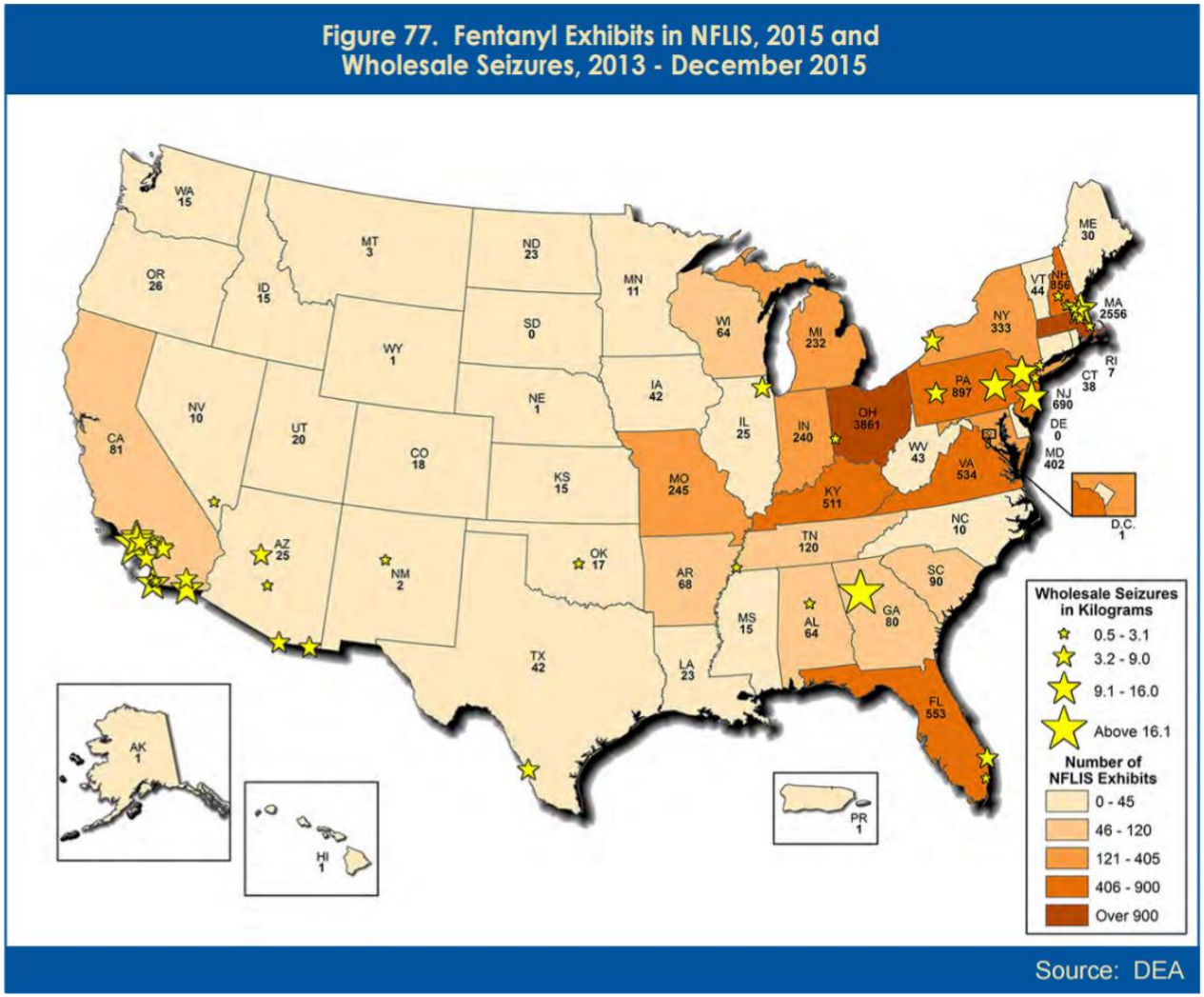
Growth of Illicit Fentanyl



Source: National Forensic Laboratory Information System (NFLIS) (2015).

Note: Data show the number of fentanyl exhibits in NFLIS, 2004–2015.

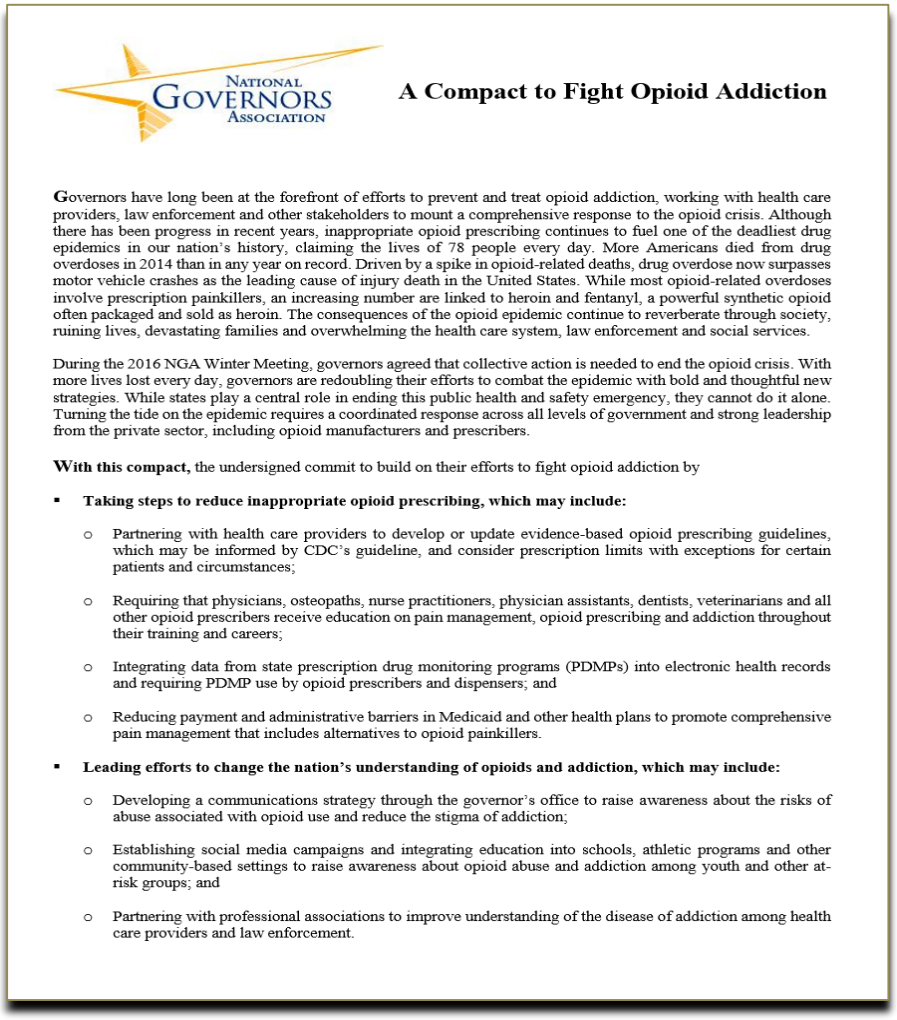
Snapshot of Illicit Fentanyl Nationally



Challenges Facing Governors in the Opioid Crisis

- This crisis is affecting constituents' lives
- The solutions are not simple
- The stigma surrounding opioid use disorder is changing

Governors Fighting the Opioid Epidemic



National Governors Association

A Compact to Fight Opioid Addiction

Governors have long been at the forefront of efforts to prevent and treat opioid addiction, working with health care providers, law enforcement and other stakeholders to mount a comprehensive response to the opioid crisis. Although there has been progress in recent years, inappropriate opioid prescribing continues to fuel one of the deadliest drug epidemics in our nation's history, claiming the lives of 78 people every day. More Americans died from drug overdoses in 2014 than in any year on record. Driven by a spike in opioid-related deaths, drug overdose now surpasses motor vehicle crashes as the leading cause of injury death in the United States. While most opioid-related overdoses involve prescription painkillers, an increasing number are linked to heroin and fentanyl, a powerful synthetic opioid often packaged and sold as heroin. The consequences of the opioid epidemic continue to reverberate through society, ruining lives, devastating families and overwhelming the health care system, law enforcement and social services.

During the 2016 NGA Winter Meeting, governors agreed that collective action is needed to end the opioid crisis. With more lives lost every day, governors are redoubling their efforts to combat the epidemic with bold and thoughtful new strategies. While states play a central role in ending this public health and safety emergency, they cannot do it alone. Turning the tide on the epidemic requires a coordinated response across all levels of government and strong leadership from the private sector, including opioid manufacturers and prescribers.

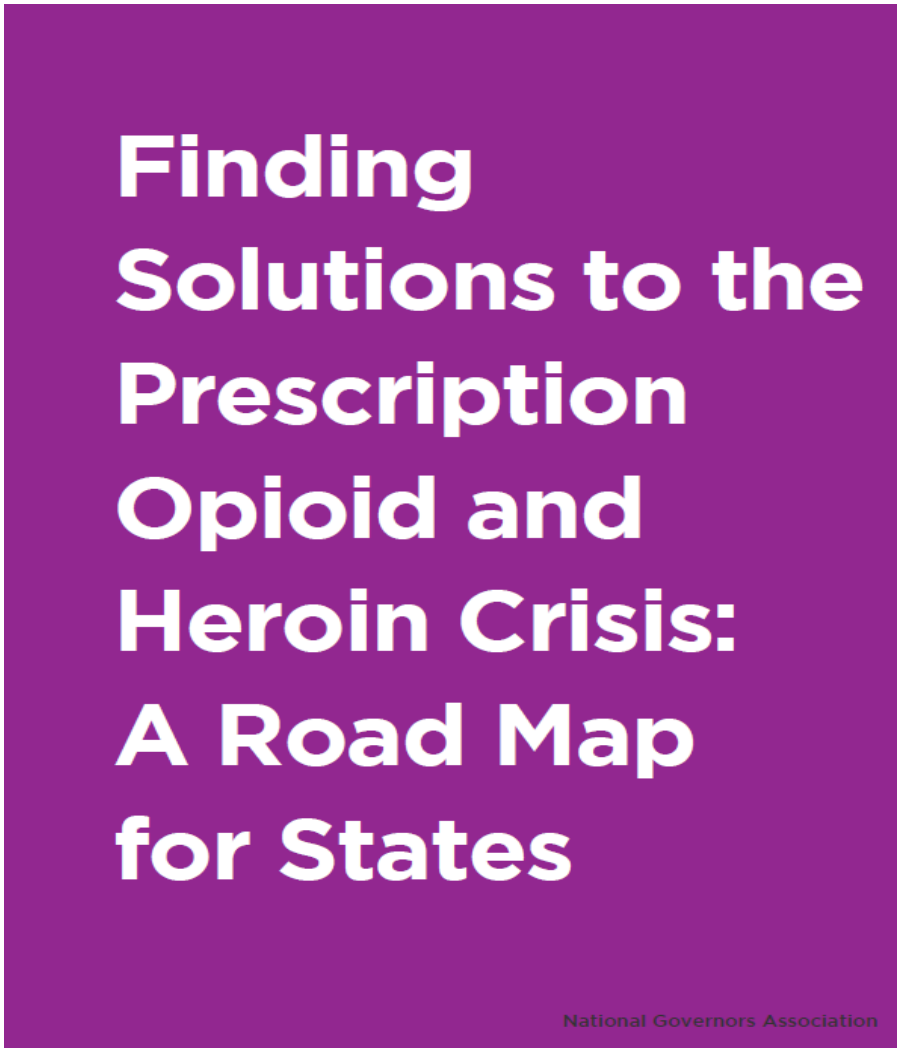
With this compact, the undersigned commit to build on their efforts to fight opioid addiction by

- **Taking steps to reduce inappropriate opioid prescribing, which may include:**
  - Partnering with health care providers to develop or update evidence-based opioid prescribing guidelines, which may be informed by CDC's guideline, and consider prescription limits with exceptions for certain patients and circumstances;
  - Requiring that physicians, osteopaths, nurse practitioners, physician assistants, dentists, veterinarians and all other opioid prescribers receive education on pain management, opioid prescribing and addiction throughout their training and careers;
  - Integrating data from state prescription drug monitoring programs (PDMPs) into electronic health records and requiring PDMP use by opioid prescribers and dispensers; and
  - Reducing payment and administrative barriers in Medicaid and other health plans to promote comprehensive pain management that includes alternatives to opioid painkillers.
- **Leading efforts to change the nation's understanding of opioids and addiction, which may include:**
  - Developing a communications strategy through the governor's office to raise awareness about the risks of abuse associated with opioid use and reduce the stigma of addiction;
  - Establishing social media campaigns and integrating education into schools, athletic programs and other community-based settings to raise awareness about opioid abuse and addiction among youth and other at-risk groups; and
  - Partnering with professional associations to improve understanding of the disease of addiction among health care providers and law enforcement.

NGA OPIOID COMPACT SIGNED BY 46 GOVERNORS IN JULY 2016

www.nga.org

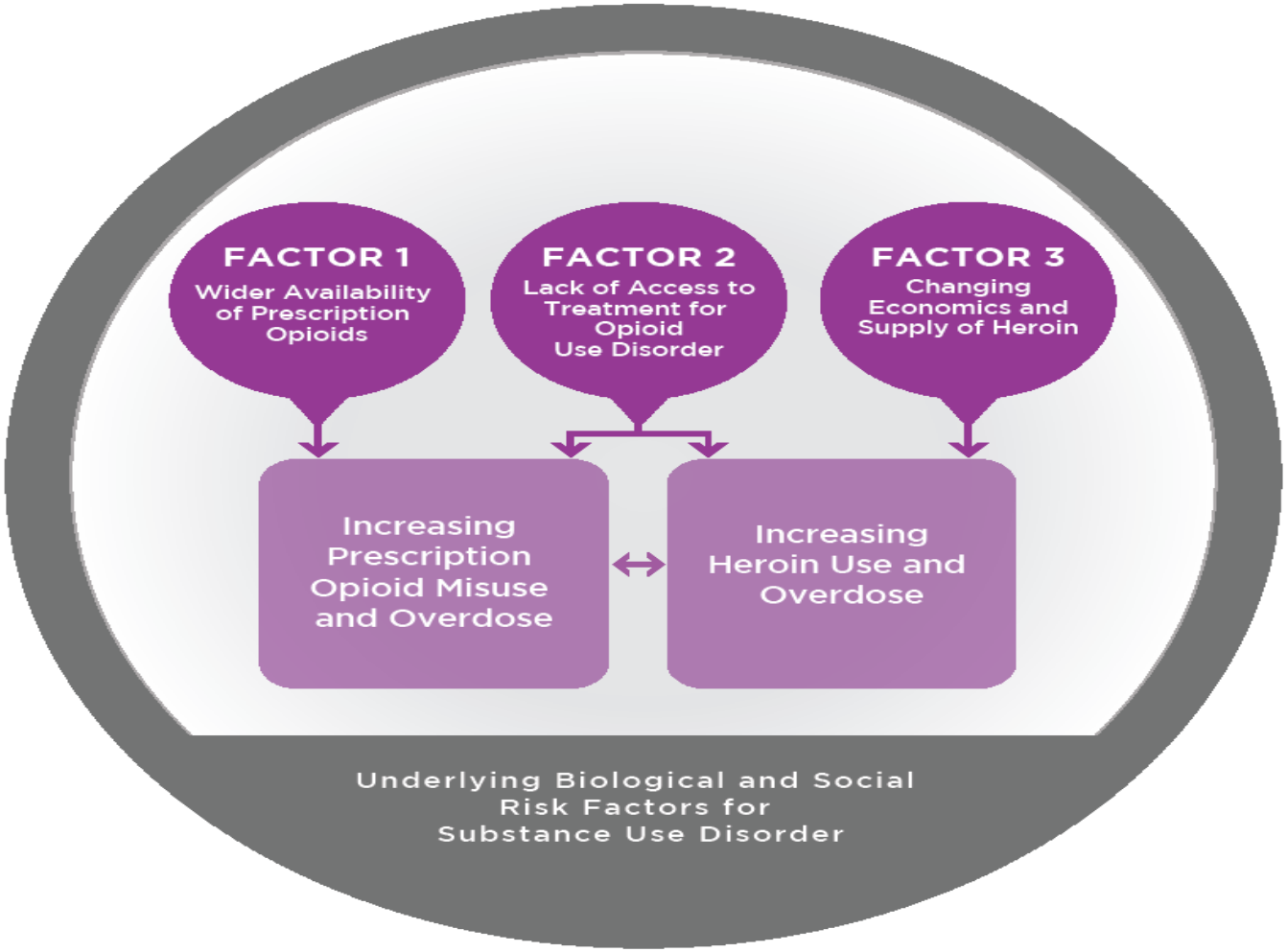
Governors Fighting the Opioid Epidemic



NGA OPIOID ROAD MAP

www.nga.org

Opioid Road Map: Key Factors



Comprehensive Policy Framework for States

Selected Prevention Strategies

- Develop and update guidelines for all opioid prescribers
- Limit new opioid prescriptions for acute pain, with exceptions for certain patients
- Develop and adopt a comprehensive opioid management program in Medicaid and in other state-run programs
- Remove methadone for managing pain from Medicaid's preferred drug list

Selected Public Safety Strategies

Reducing supply of and demand for illicit opioids:

- Establish a collaborative information-sharing environment that breaks down silos across state agencies to better understand trends
- Use assets from partners to improve data collection and intelligence sharing to restrict the supply of illicit opioids
- Expand statutory tools for prosecuting major distributors
- Expand partnerships and data access to better target overprescribers

Selected Public Safety Strategies

Responding to the crisis:

- Empower, educate, and equip law enforcement personnel to prevent overdose deaths and facilitate access to treatment
- Reinforce use of best practices in drug treatment courts
- Ensure access to MAT in correctional facilities and upon re-entry into the community
- Strengthen pre-trial drug diversion programs to give people the chance to enter substance use treatment

Hot Topics from States

- Establish a collaborative data and information-sharing environment
- Limit new opioid prescriptions for acute pain, with exceptions
- Expand use of non-opioid therapies for pain
- Increase access to naloxone
- Expand and strengthen the treatment and recovery workforce
- Increase access to MAT in corrections and with re-entry

Drug-Monitoring Data and Information Sharing

Law enforcement	Health/human services
Specimen submissions for testing	EMS naloxone deployment data
Lab results (opioid and non-opioid pills, heroin, meth, cocaine, marijuana, bath salts)	Toxicology results on overdose deaths
Law enforcement naloxone deployments	Prescription monitoring programs
Thefts	Addiction treatment admissions
Shootings	Urinalysis results

Value of Real-Time Data

- States face a variety of data-related challenges, including:
  - Problems with data use agreements
  - Agency territory issues
  - Questions about personally identifiable information
  - Intergovernmental challenges
  - Privacy concerns
- States are facilitating data as quickly as they can for drug supply intelligence (e.g., stamps) and to push prevention and treatment resources toward overdose spikes

Potential Opportunities for Wastewater Testing

- **May offer an additional layer for states to add to their data analysis**
- **A better picture of the epidemic, drug supply, and consumption patterns could help states guard against "squeezing the balloon"**
- **Previous studies exist on meth, MDMA, amphetamines, cocaine, heroin, methadone, and morphine in wastewater-based epidemiology in Nevada, Utah, South Carolina, Nebraska, and New York***

*European Monitoring Centre for Drugs and Drug Addiction, "Assessing Illicit Drugs in Wastewater," 2016.

Questions and Challenges for Wastewater Testing

- States are focused on data (e.g., data to drive policy, data dashboards, DMI, etc.) to target limited resources
- Needs to help states target interventions proactively
- Will wastewater testing offer real-time estimates as a potential complementary tool?*
- Can it help alert LE to new substances and track changes in drug use over time?*

*European Monitoring Centre for Drugs and Drug Addiction, "Assessing Illicit Drugs in Wastewater," 2016.

Questions and Challenges for Wastewater Testing

- What role does law enforcement have in working with wastewater treatment plants?
- What are the limitations in time frame analyses between drug use surveys and wastewater analysis?
- Challenges with financing—how can states afford to pilot programs or support this work?
- What types of conversations do state labs, wastewater plants, environmental quality agencies, and law enforcement need to have?

For More Information

- **Jeffrey Locke, senior policy analyst**
  - **jlocke@nga.org**
  - **@jeffreyRlocke (Twitter)**

Panel Discussion

Jeffrey Locke
National Governors Association

Capt. Juan Colon
New Jersey State Police

Jeff Beeson
High Intensity Drug Trafficking Area Program

Capt. Jen Fan
Substance Abuse and Mental Health Services Administration

MATHEMATICA
Policy Research

Drug Monitoring Initiative:

A Drug Intelligence Capability for Healthcare & Public Safety Partners

Wastewater Symposium
Washington, DC

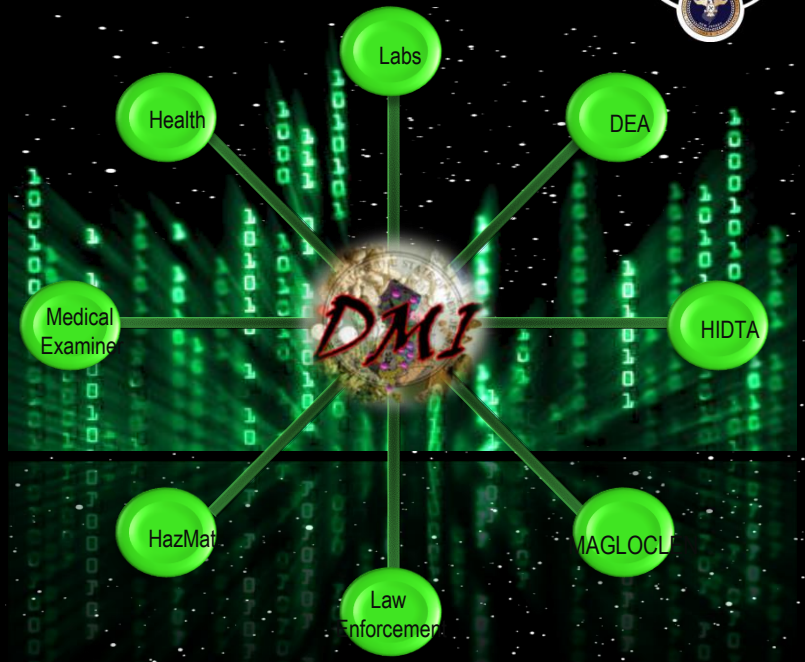
May 16, 2017

Captain Juan Colon – New Jersey State Police
New Jersey Office of the Attorney General

DMI DATA SETS COLLECTED

- **Crimes**
  - Drug Seizures/Lab results
    - Heroin
    - Pills
    - Methamphetamine
    - Cocaine
    - Marijuana Variants
    - Synthetics
  - Shootings
  - Gun Recoveries
  - Drug Arrests
  - LE Narcan Deployments

User & Dealer Arrests



- **Health/Human Services**
  - EMS Narcan Deployment Data
  - Toxicology Data on Overdose Deaths
  - Prescription Drug Monitoring Program
  - Addiction Treatment Admissions
    - Children and Families
    - DHS
  - Urinalysis results
  - Medicaid Data

	Count	Drug Name	Department Name	Offense Location	Offense Date	County
2	5	**Buprenorphine**	Elmwood Park PD	River Drive Elmwood Park	5/26/2013	BER
3	1	**Buprenorphine**	NJSP Tuckerton - Troop C	Us-9 Sb, M.P. 56, Bass River Twp.	6/22/2013	BUR
4	4	**Buprenorphine**	NJ Transit PD - Atlantic City	Camden Transportation Center	5/20/2013	CAM
5	6	**Buprenorphine**	Cherry Hill Twp PD	Rt 38 & Chapel Ave, Cherry Hill	6/11/2013	CAM
6	1	**Buprenorphine**	Cherry Hill Twp PD	Rt 38 & Hollywood Ave,Cherry Hill	6/16/2013	CAM
7	2	**Buprenorphine**	Haddon Heights PD	White Horse Pike	6/22/2013	CAM
8	1	**Buprenorphine**	Runnemede PD	525 North Oakland Ave. Runnemede	6/28/2013	CAM
9	1	**Buprenorphine**	Nutley PD	Parrellel St And Harrison St	5/15/2013	ESS
10	1	**Buprenorphine**	Monroe Twp PD (GLO)	1237 Janvier Rd	6/4/2013	GLO
11	6	**Buprenorphine**	Deptford Twp. PD	131 Blackwood Barnsboro Rd	6/13/2013	GLO
12	2	**Buprenorphine**	Harrison Twp PD	705 Mullica Hill Rd	7/7/2013	GLO
13	9	**Buprenorphine**	Edison Twp. PD	Maplewood Ave/Redfield Village	6/10/2013	MID
14	1	**Buprenorphine**	Howell Twp PD	Rt 9 / Aldrich Rd	6/28/2013	MON
15	2	**Buprenorphine**	Wall Twp PD	State Highway 138 Club Drive, Wall Twp	5/9/2013	MON
16	1	**Buprenorphine**	Tinton Falls PD	Ann Court	7/17/2013	MON
17	15	**Buprenorphine**	Matawan PD	Aberdeen Rd, Matawan Boro	7/8/2013	MON
18	2	**Buprenorphine**	Dover PD	91 Park Heights Avenue Apt 1C, Dover	6/17/2013	MOR
19	1	**Buprenorphine**	Wanaque Boro PD	Haskell Ave., Haskell	6/4/2013	PAS
20	1	**Buprenorphine**	Somerville PD	17 Reimer St Somerville	5/20/2013	SOM
21	8	**Codeine**	Pennsville PD	26 Harrison St Deepwater (Pennsville Twp)	4/24/2013	SAL
22	4	**Codeine**	Independence Twp PD	Russling Rd	5/9/2013	WAR
23	4	**Hydrocodone**	Winslow Twp PD	31 Colts Neck Drive Sicklerville	6/16/2013	CAM
24	5	**Hydrocodone**	Cumberland C P O/NARC	301 North 5Th St, Apartment 4, Millville	5/22/2013	CUM
25	5	**Hydrocodone**	Millville PD	Millville Senior High School Millville	4/9/2013	CUM
26	41	**Hydrocodone**	Essex C S O (E.C.B.N.)	394 Irvine Turner Blvd Newark	1/5/2011	ESS
27	6	**Hydrocodone**	Milltown PD	South Main St. Milltown	6/16/2013	MID

Forensic Crime Lab
Drug Examination Results

NJSP OFS Heroin Glassine Stamp Data

November 10, 2015

Lab Case	Glassine count	Color	/ Stamp	Department Name	Offense Location	Offense	Count
C15-06079 Heroin	1	RED	BRAINSTORM	NJSP Somerville	SH 24, MP 10 Springfield Twp	10/3/15	UNI
C15-05902 Fentanyl	2	BLACK	EMPIRE	NJSP Bordentown	1324 East Yoppa St. Wrighstown	9/28/15	BUR
C15-06026 Heroin	5	BLACK	PANDA (PANDA)	Trenton PD - CEB	Known	9/18/15	MER
C15-06023 Heroin Cocaine Fentanyl	8	PURPLE	TEETH	Trenton PD - CEB	Swan St/Whittaker Ave	8/15/15	MER
C15-06034 Heroin	10	BLUE	THOR	Trenton PD - CEB	1677 Pek St	9/24/15	MER
E15-06019 Heroin	3	RED	DOPE IMAGE OF LIT BOMI	Rutgers University PD	Lot 86 Rutgers University New Brunswick, NJ	10/14/15	MID
E15-06067 Acetyl Fentanyl	1	GREEN	GAS FACE (SKULL WITH G	Asbury Park PD	City of Asbury Park	10/20/15	MON
E15-05990 Acetyl Fentanyl	6	BLUE	HOT 97	Middletown PD	194 Kag Dr. Middletown, NJ	10/9/15	MON
E15-06159 heroin	10	RED	MIRACLE (STAR)	Monmouth County Prosecutor's Office - NTF	133 Hwy 35 Neptune City, NJ	10/23/15	MON
E15-05990 Acetyl Fentanyl	10	BLACK	PICTURE OF DICE	Middletown PD	194 Kag Dr. Middletown, NJ	10/9/15	MON
S15-08536 Heroin	1	GREEN	PREDATOR	Deptford Twp. PD	CLEMENTS BRIDGE ROAD	10/11/15	GLO
E15-05990 Acetyl Fentanyl	20	PURPLE	THE FIXX	Middletown PD	194 Kag Dr. Middletown, NJ	10/9/15	MON
E15-05990 Acetyl Fentanyl	25	PURPLE	THE FIXX	Middletown PD	194 Kag Dr. Middletown, NJ	10/9/15	MON
N15-08865 heroin	1	RED	151	NJSP Sussex	NJSP SUSSEX STATION	10/20/15	SUS

Medical Examiner's Toxicology Results - 2015

County	Age	Race	Gender	MOD	ALCOHOL	HEROIN	MORPHINE	COCAINE	FENTANYL	ACETYL FENTANYL	OXYCODONE	METHADONE	Body Found	City
Atlantic	27	Hispanic	Male	Accident		HEROIN		COCAINE	FENTANYL	ACETYL FENTANYL			Temporary	Atlantic City
Bergen	29	White	Male	Accident		HEROIN		COCAINE	FENTANYL	ACETYL FENTANYL			Residence	Hackensack
Bergen	25	White	Male	Accident		HEROIN			FENTANYL	ACETYL FENTANYL			Residence	Garfield
Bergen	48	White	Male	Accident					FENTANYL	ACETYL FENTANYL			Scene	Paramus
Bergen	23	White	Male	Accident		HEROIN			FENTANYL	ACETYL FENTANYL			Residence	UPPER Saddle River
Bergen	30	Hispanic	Male	Accident					FENTANYL	ACETYL FENTANYL	OXYCODONE		Residence	Franklin Lakes
Bergen	32	White	Male	Accident		HEROIN			FENTANYL	ACETYL FENTANYL			Residence	Fair Lawn
Essex	52	Black	Female	Accident		HEROIN			FENTANYL	ACETYL FENTANYL			Residence	Newark
Hudson	40	Black	Male	Accident		HEROIN		COCAINE	FENTANYL	ACETYL FENTANYL				Lincoln Park
Hudson	31	White	Male	Accident	ETHANOL	HEROIN			FENTANYL	ACETYL FENTANYL			Residence	Hoboken
Mercer	36	White	Male	Accident					FENTANYL	ACETYL FENTANYL			Residence	Trenton
Mercer	45	White	Male	Accident	ETHANOL	HEROIN		COCAINE	FENTANYL	ACETYL FENTANYL			Residence	LAWRENCEVILLE TOWNSHIP
Mercer	27	White	Female	Accident		HEROIN		COCAINE	FENTANYL	ACETYL FENTANYL			Residence	HAMILTON
Middlesex	49	White	Female	Accident	ETHANOL				FENTANYL	ACETYL FENTANYL		METHADONE	Residence	Metuchen
Middlesex	31	White	Male	Accident		HEROIN			FENTANYL	ACETYL FENTANYL			Residence	South Amboy
Middlesex	58	Black	Male	Accident		HEROIN			FENTANYL	ACETYL FENTANYL			Scene	North Brunswick Township
Middlesex	26	White	Female	Accident		HEROIN			FENTANYL	ACETYL FENTANYL			Scene	PORT READING (WOODBRIDG
Monmouth	28	White	Male	Accident		HEROIN			FENTANYL	ACETYL FENTANYL			Residence	Millstone
Morris	31	Asian	Male	Accident	ETHANOL	HEROIN			FENTANYL	ACETYL FENTANYL			Residence	ROXBURY
Morris	26	White	Male	Accident		HEROIN		COCAINE	FENTANYL	ACETYL FENTANYL			Public Area	Mt. Olive

2016 Adulterants Breakdown

01/01/2016 - 12/31/2016

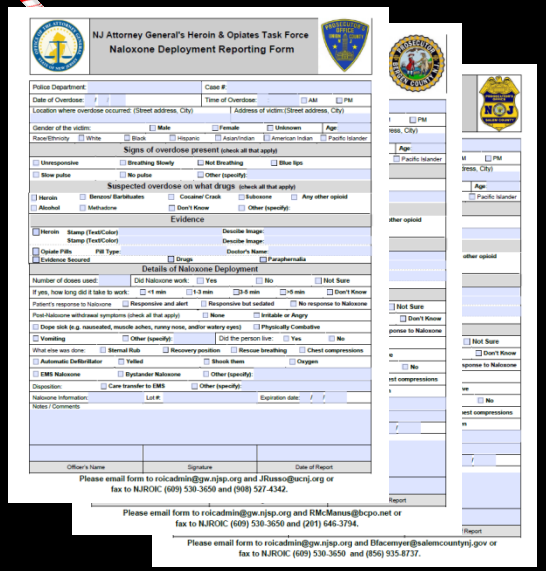
Content	Fatal	OD	Seizure	Grand Total
Fentanyl	45	31	196	272
Fentanyl/Acetyl Fentanyl	3	2	5	10
Fentanyl/Caffeine/Acetaminophen/Diphenhydramine/Aminopyrene	1			1
Fentanyl/Furanyl Fentanyl	2			2
Fentanyl/Heroin/U-47700	1			1
Fentanyl/Ketamine/U-47700		1		1
Fentanyl/Para-Fluoroisobutyryl Fentanyl/Furanyl Fentanyl/Heroin	1			1
Fentanyl/Xylazine/Caffeine	1			1
Furanyl Fentanyl	26	9	99	134
Furanyl Fentanyl/Deschloroketamine			1	1
Furanyl Fentanyl/Deschloroketamine/Para-Fluoroisobutyryl Fentanyl			1	1
Furanyl Fentanyl/Fentanyl			1	1
Furanyl Fentanyl/Para-Fluoroisobutyryl Fentanyl	2		1	3
Furanyl Fentanyl/U-47700			1	1
Furanyl Fentanyl/U-47700/Valeryl Fentanyl			1	1
Furanyl Fentanyl/Valeryl Fentanyl/U-47700			5	5
Methocarbamol/Deschloroketamine/Para-Fluoroisobutyryl Fentanyl			1	1
Noscapine			8	8
Para-fluorobutyryl fentanyl			1	1
Para-fluorobutyryl Fentanyl/Furanyl Fentanyl/Heroin	1			1
Para-fluorobutyryl fentanyl/Heroin/Fentanyl	1	1		2
Para-Fluoroisobutyryl Fentanyl		2	11	13
Para-Fluoroisobutyryl Fentanyl/Deschloroketamine		2		2
Para-Fluoroisobutyryl Fentanyl/Deschloroketamine/Furanyl Fentanyl			1	1
Para-Fluoroisobutyryl Fentanyl/Furanyl Fentanyl	4	1		5
Paroxetine		1		1

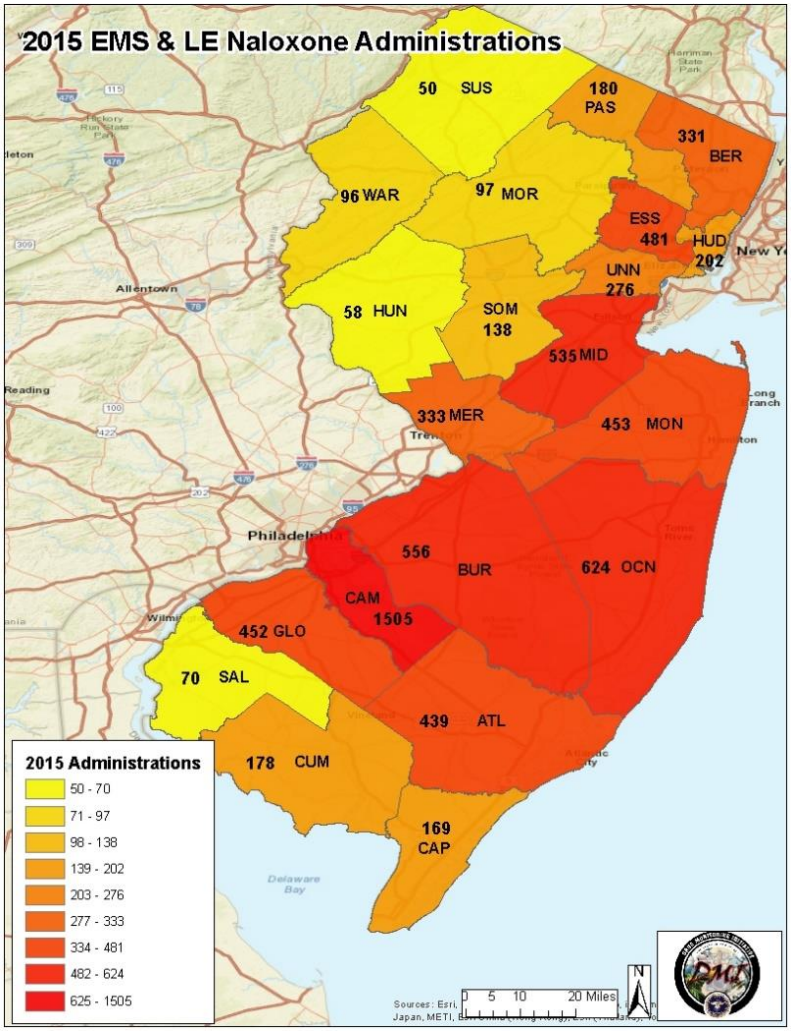
ALERT!

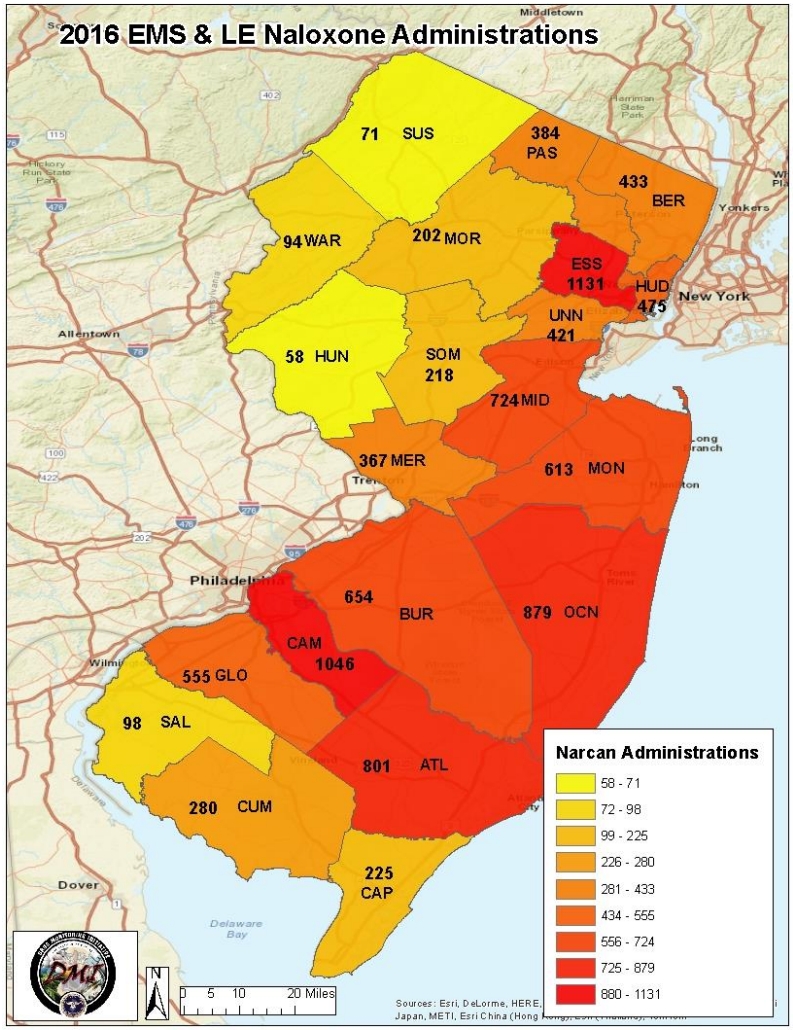
5 or more administrations
10 mile radius
12 hours

Fatal & Non Fatal Overdoses

NJ Health
New Jersey Department of Health




2015 EMS & LE Naloxone Administrations
50 SUS
180 PAS
331 BER
96 WAR
97 MOR
ESS 481
HUD 202
UNN 276
58 HUN
SOM 138
535 MID
333 MER
453 MON
556 BUR
624 OCN
CAM 1505
452 GLO
70 SAL
439 ATL
178 CUM
169 CAP
2015 Administrations
50 - 70
71 - 97
98 - 138
139 - 202
203 - 276
277 - 333
334 - 481
482 - 624
625 - 1505
Allentown
Reading
Philadelphia
Wilmington
Delaware Bay
0 5 10 20 Miles
N


2016 EMS & LE Naloxone Administrations
71 SUS
384 PAS
433 BER
94 WAR
202 MOR
ESS 1131
HUD 475
UNN 421
58 HUN
SOM 218
724 MID
367 MER
613 MON
654 BUR
879 OCN
CAM 1046
555 GLO
98 SAL
801 ATL
280 CUM
225 CAP
Narcan Administrations
58 - 71
72 - 98
99 - 225
226 - 280
281 - 433
434 - 555
556 - 724
725 - 879
880 - 1131
Allentown
New York
Yonkers
Philadelphia
Dover
Delaware Bay
0 5 10 20 Miles
N

Naloxone Deployments By County 2015, 2016, 2017

Rank		2015 Total
1	Camden	1505
2	Ocean	624
3	Burlington	556
4	Middlesex	535
5	Essex	481
6	Monmouth	453
7	Gloucester	452
8	Atlantic	439
9	Mercer	333
10	Bergen	331
11	Union	276
12	Hudson	202
13	Passaic	180
14	Cumberland	178
15	Cape May	169
16	Somerset	138
17	Morris	97
18	Warren	96
19	Salem	70
20	Hunterdon	58
21	Sussex	50

	2016 Total
Essex	1131
Camden	1046
Ocean	879
Atlantic	801
Middlesex	724
Burlington	654
Monmouth	613
Gloucester	555
Hudson	475
Bergen	433
Union	421
Passaic	384
Mercer	367
Cumberland	280
Cape May	225
Somerset	218
Morris	202
Salem	98
Warren	94
Sussex	71
Hunterdon	58

	2017 Total
Camden	58
Hudson	45
Middlesex	37
Burlington	33
Passaic	32
Gloucester	27
Atlantic	26
Bergen	26
Union	24
Mercer	19
Morris	16
Ocean	13
Cumberland	12
Monmouth	9
Salem	9
Somerset	8
Sussex	7
Cape May	6
Essex	6
Hunterdon	4
Warren	2

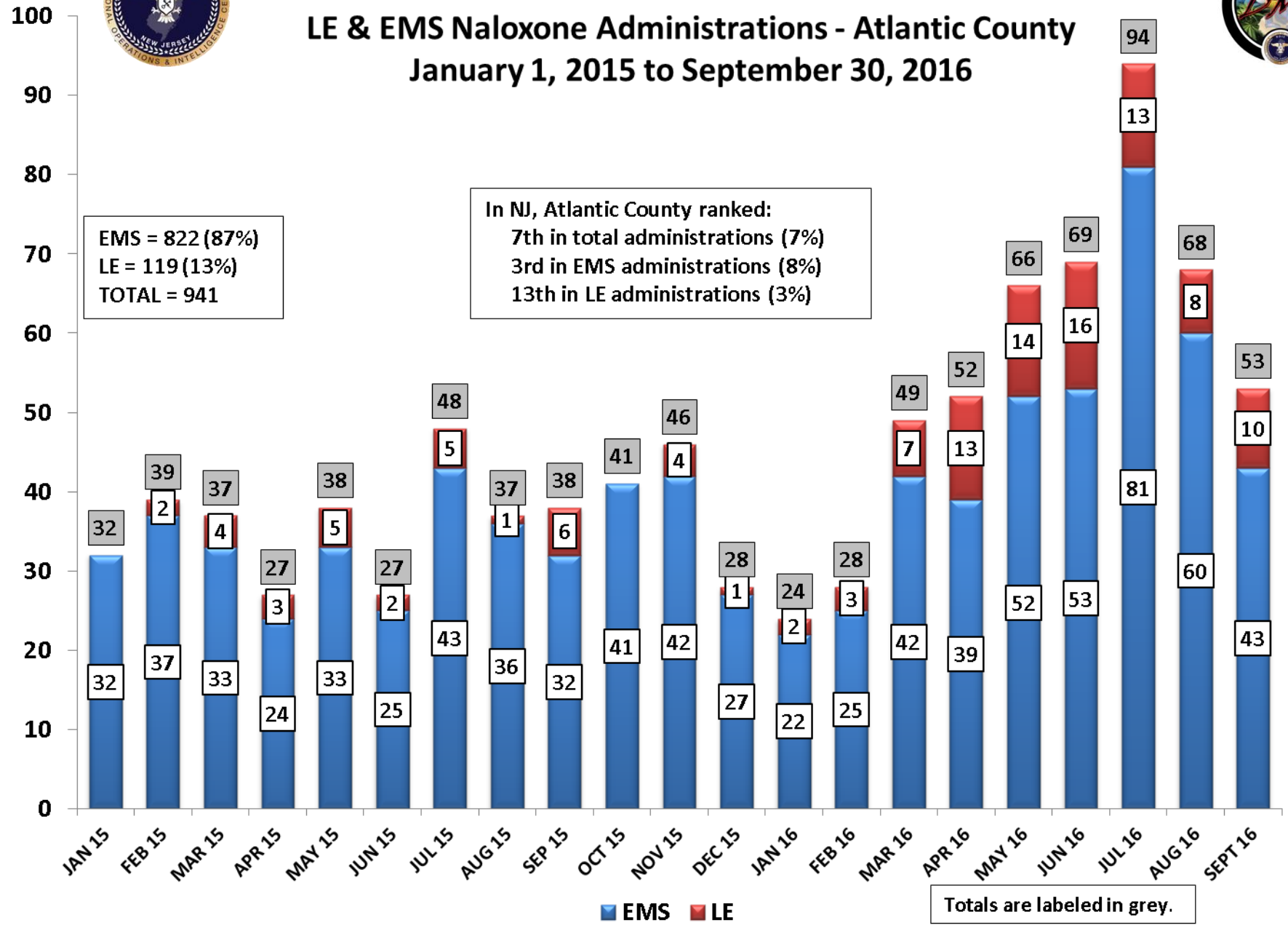
Opioid-Related Categories: 1/1/2015 to 6/30/2016							
County	Suspected Heroin Submissions	Analyzed Heroin Glassine Bags	Fentanyl Submissions	LE & EMS Naloxone Administrations	*Drug Deaths	Drug-Related Arrests	
						Distribution	Possession
Atlantic	1,128	75,430	91	715	85	1,151	1,523
Bergen	752	29,782	63	537	85	1,686	3,847
Burlington	686	7,449	59	770	87	864	2,168
Camden	1,782	23,921	147	1,905	191	3,148	4,036
Cape May	761	29,718	25	257	32	481	428
Cumberland	176	6,371	7	262	38	614	1,232
Essex	1,747	145,099	134	1,057	146	3,814	5,107
Gloucester	244	2,371	44	643	65	865	2,061
Hudson	825	25,563	14	434	107	2,264	2,238
Hunterdon	167	4,852	13	85	14	214	324
Mercer	928	68,669	33	464	59	1,388	2,060
Middlesex	762	28,357	56	815	106	1,715	3,545
Monmouth	1,437	74,048	129	793	122	1,820	3,353
Morris	469	8,871	53	170	44	765	1,864
Ocean	2,403	121,972	242	1,063	157	1,612	2,574
Passaic	1,328	121,940	81	348	83	2,439	3,361
Salem	46	1,049	3	103	18	193	403
Somerset	212	19,547	28	252	35	263	936
Sussex	236	5,415	29	80	25	241	576
Union	1,395	46,073	94	462	67	1,487	3,418
Warren	184	3,313	23	136	21	176	345
Total	**17,668**	**849,810**	**1,368**	**11,351**	**1,587**	**27,200**	**45,399**

***Source: New Jersey Office of the State Medical Examiner, 2015 Drug Related Deaths.**

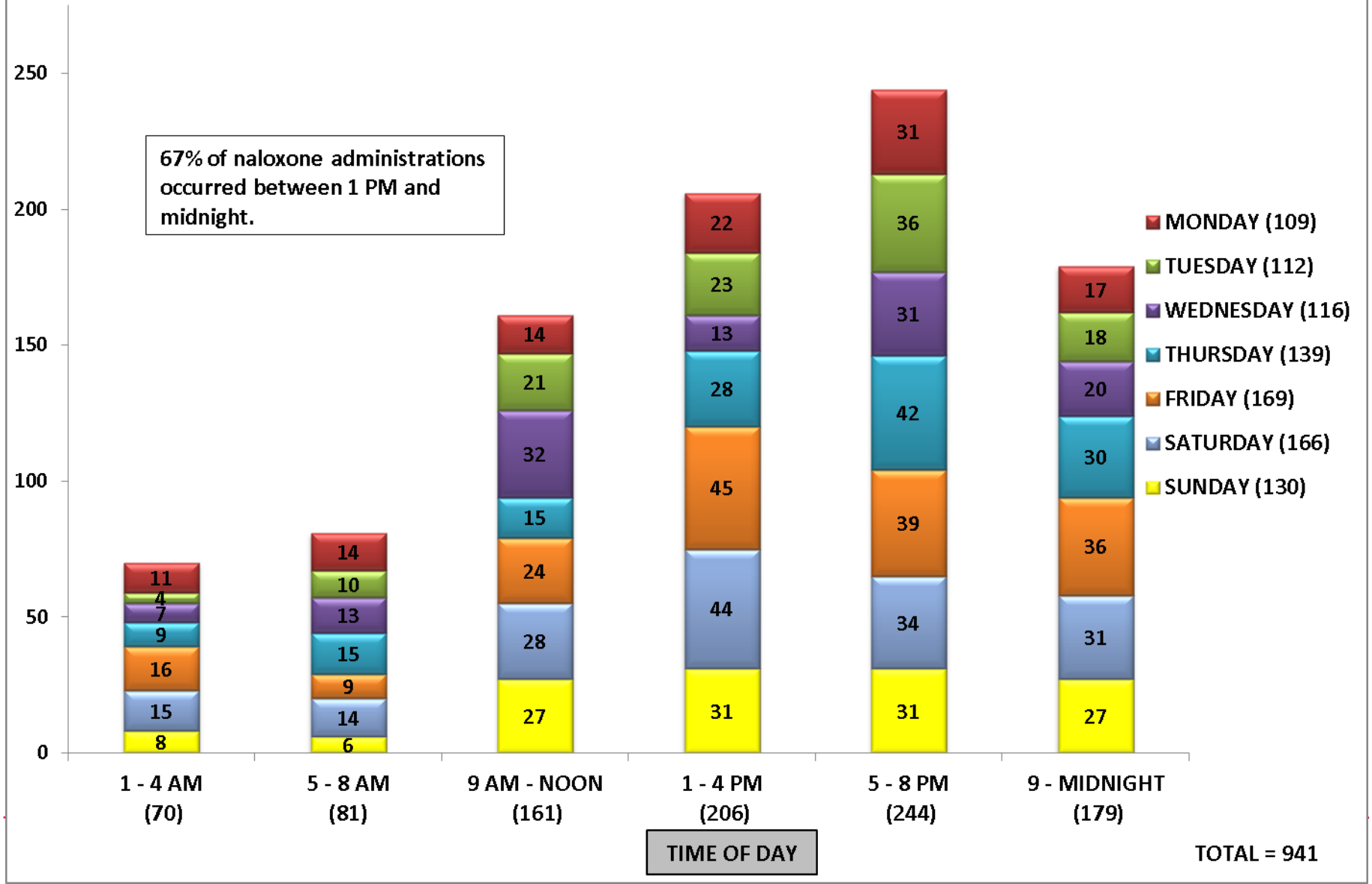
Opioid-Related Rankings: 1/1/2015 to 6/30/2016									
County	Suspected Heroin Submissions	Analyzed Heroin Glassine Bags	Fentanyl Submissions	LE & EMS Naloxone Administrations	*Drug Deaths	Drug-Related Arrests		Sum of Categories	Final Rank
						Distribution	Possession		
Essex	3	1	3	3	3	1	1	15	1
Camden	2	12	2	1	1	2	2	22	2
Ocean	1	2	1	2	2	8	8	24	3
Monmouth	4	5	4	5	4	5	7	34	4
Passaic	6	3	7	13	10	3	6	48	5
Middlesex	10	10	10	4	6	6	4	50	6
Union	5	7	5	11	11	9	5	53	7
Bergen	12	8	8	9	9	7	3	56	8
Atlantic	7	4	6	7	8	11	14	57	9
Hudson	9	11	18	12	5	4	9	68	10
Mercer	8	6	13	10	13	10	12	72	11
Burlington	13	15	9	6	7	13	10	73	12
Gloucester	15	20	12	8	12	12	11	90	13
Morris	14	14	11	17	14	14	13	97	14
Cape May	11	9	16	15	17	16	18	102	15
Somerset	17	13	15	16	16	17	16	110	16
Cumberland	19	16	20	14	15	15	15	114	17
Sussex	16	17	14	21	18	18	17	121	18
Warren	18	19	17	18	19	21	20	132	19
Hunterdon	20	18	19	20	21	19	21	138	20
Salem	21	21	21	19	20	20	19	141	21

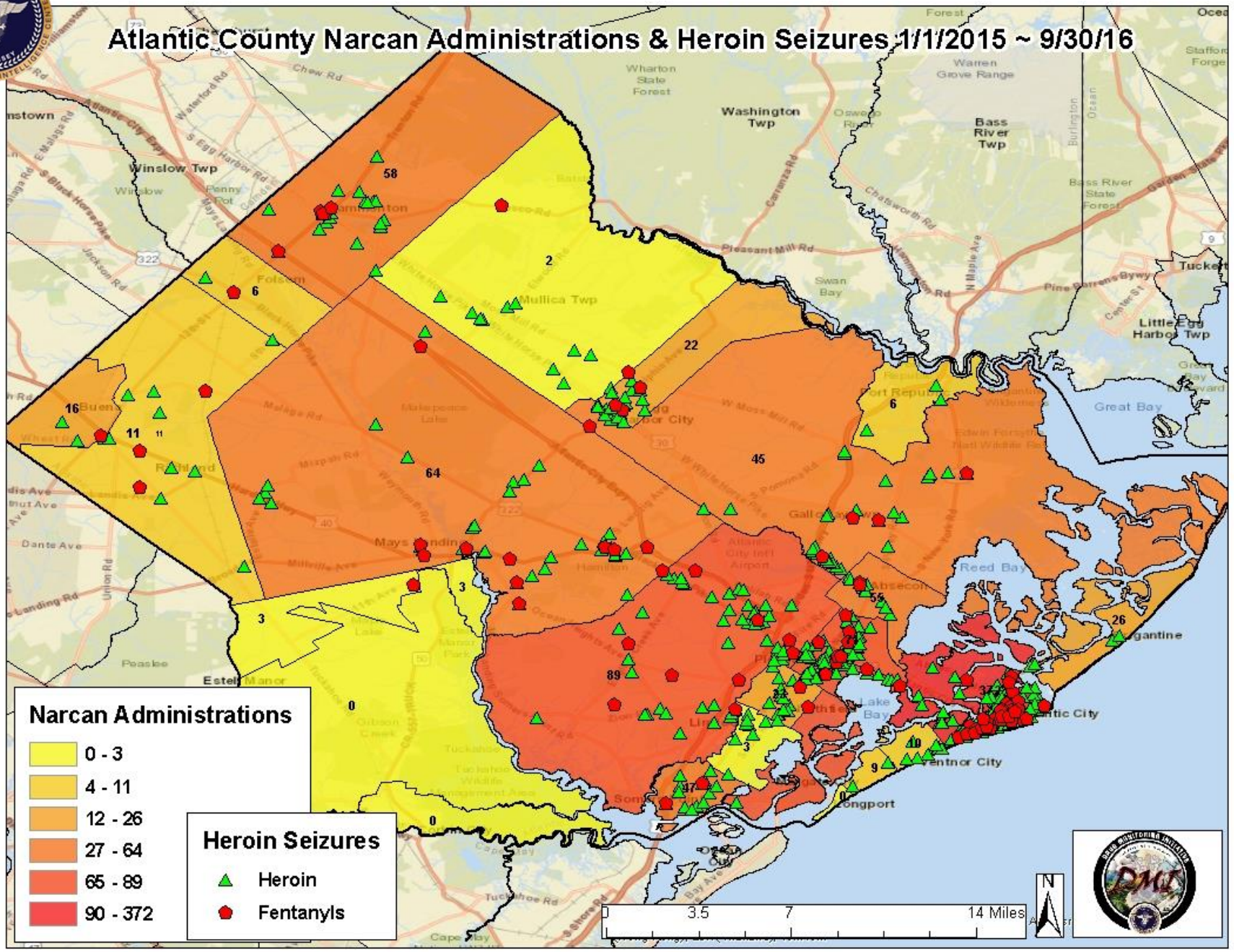
*Source: New Jersey Office of the State Medical Examiner, 2015 Drug Related Deaths.

LE & EMS Naloxone Administrations - Atlantic County
January 1, 2015 to September 30, 2016



LE & EMS Naloxone Administrations - Atlantic County
January 1, 2015 to September 30, 2016




Atlantic County Narcan Administrations & Heroin Seizures 1/1/2015 ~ 9/30/16
Narcan Administrations
0 - 3
4 - 11
12 - 26
27 - 64
65 - 89
90 - 372
Heroin Seizures
Heroin
Fentanyls
0 3.5 7 14 Miles
N
Washington Twp
Bass River Twp
Winslow Twp
Mullica Twp
Little Egg Harbor Twp
Port Republic
Egg Harbor City
Mays Landing
Estell Manor
Pleasantville
Absecon
Ventnor City
Longport
Great Bay
Reed Bay
Lake Bay
Swan Bay
Bass River State Forest
Wharton State Forest
Warren Grove Range
58
2
6
22
16
11
64
45
3
0
89
55
26
37
10
9

Identification Of At-Risk Individuals

Last Name	First Name	M	DOB	Age At Last Arrest	Sex	Race	[redacted]	DMI POM Score	Naloxone Administration	Total Drug & Theft Arrest	Theft Arrests	Drug Arrests	E & D
[redacted]	[redacted]	J	[redacted]	23	MALE	W	[redacted]	41	2	22	9	7	
		L		55	MALE	B		36	0	26	16	4	
		E		21	MALE	W		35	0	18	1	16	
N		J	1	24	MALE	W		34	1	19	7	9	
		R		56	MALE	B		33	1	26	22	2	
		-		30	MALE	W		33	0	24	15	1	
		J		27	MALE	W		33	1	18	6	9	
		J		42	MALE	B		32	0	24	16	3	
		C		39	MALE	B		31	1	16	4	7	
		L		26	FEMALE	W		31	1	14	0	13	
R		L		33	MALE	B		29	0	21	13	5	
		G		27	MALE	B		29	0	18	7	7	
		A		26	MALE	W		29	1	17	8	9	
		P		25	MALE	W		29	1	16	6	5	
		C		29	MALE	B		29	1	16	6	7	
		V		23	MALE	B		29	1	14	2	12	
		V		27	MALE	W		28	0	19	10	7	
		R		22	FEMALE	W		28	0	17	6	10	
E		R		50	MALE	W		28	0	16	4	5	
		-		47	MALE	B		28	0	15	2	11	
		M		21	MALE	W		28	0	15	2	12	
		R		31	MALE	W		28	1	13	1	12	
		L		53	MALE	B		27	1	15	6	8	

For More Information

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VIII. Using advanced analytics to enhance decision making

Ravi Goyal

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MATHEMATICA
Policy Research

Using Advanced Analytics to Enhance Decision Making

Wastewater Symposium
Washington, DC

May 16, 2017

Ravi Goyal • Sarah LeBarron • Jonathan Geller • Jiaqi Li • Ellen Bouchery • Aparna Keshaviah

Background

- **The opioid epidemic is a complex problem requiring a multifaceted, collaborative approach by agencies, including those in public health and law enforcement[1, 2]**
- **Collaborative, data-driven efforts should become standard practice in developing, assessing, and adjusting policies and programming[2]**
- **Techniques to conduct analytics have greatly advanced in the past several years**

1. Rudd, Rose A. "Increases in Drug and Opioid-Involved Overdose Deaths—United States, 2010–2015." *Morbidity and Mortality Weekly Report*, vol. 65, 2016.
2. Massachusetts Department of Public Health. “An Assessment of Opioid-Related Deaths in Massachusetts.” 2016.

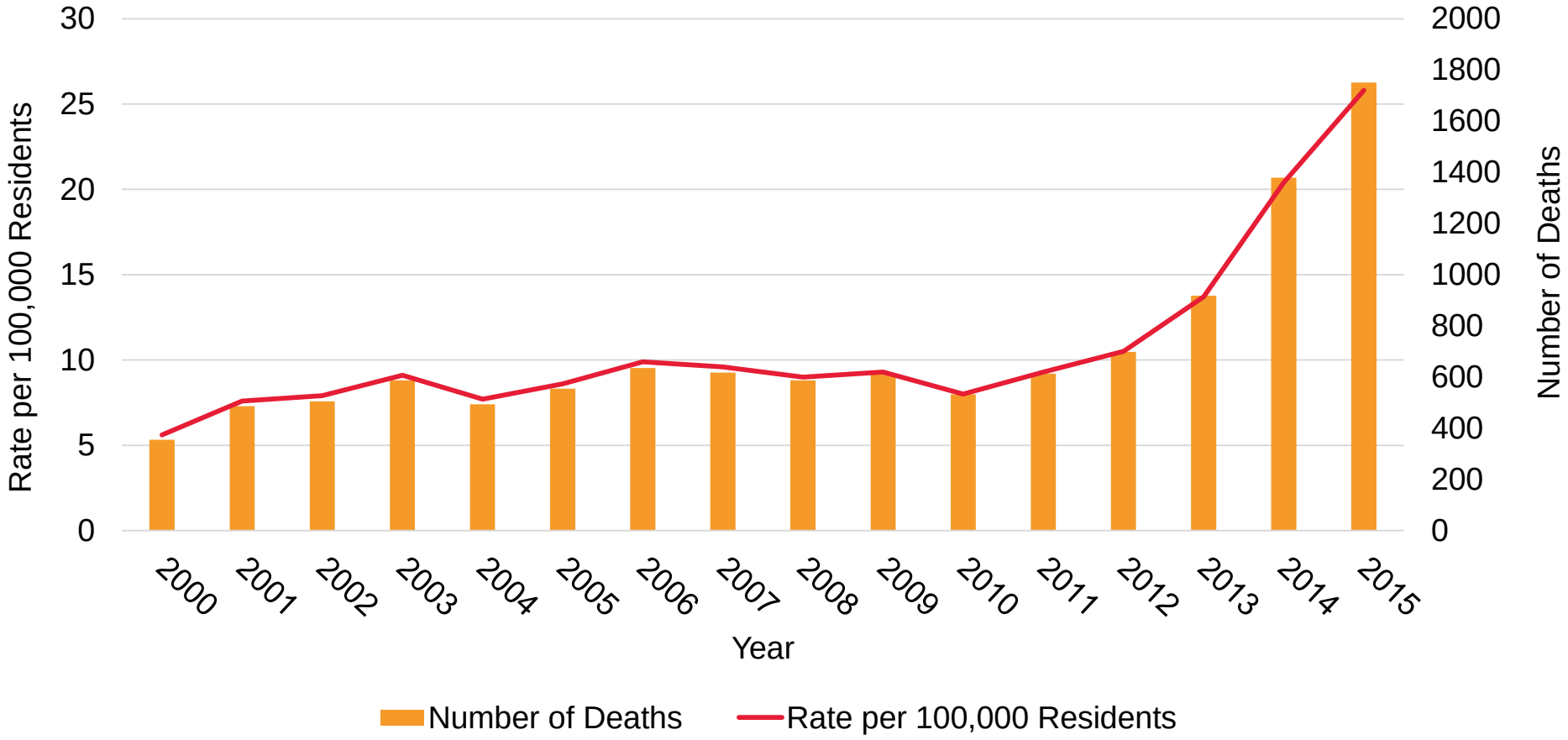
Objectives

- Investigate what can be learned about the opioid epidemic in Massachusetts (MA) by combining multiple data sets aggregated at the city/town level
  - Wastewater will most likely be collected at centralized locations, such as treatment facilities
  - Wastewater data will most likely be combined with data at a regional/community level because linkage to individual-level data will be challenging
- Compare our findings with those conducted by linking dataset at the individual-level

Study

- **Main**
  - Predict opioid-related fatality rates (deaths per 100,000 residents) for each city or town in MA based on data from previous years
- **Secondary**
  - Identify data sets from federal and state agencies that provide information on the epidemic
  - Identify appropriate analytical methods

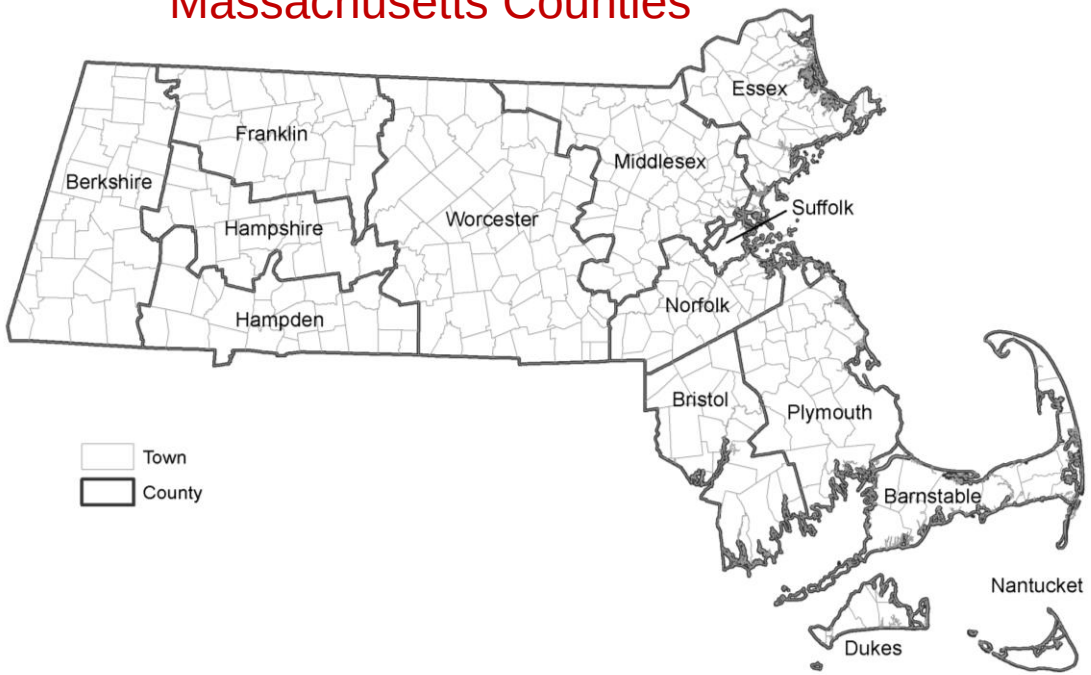
MA Opioid-Related Overdose Deaths



MA Information

- **Population: 6.8 million**
- **Number of counties: 14**
- **Number of cities and towns: 351**
  - **Smallest: Gosnold—77 (2015 est.)**
  - **Largest: Boston—667,137 (2015 est.)**

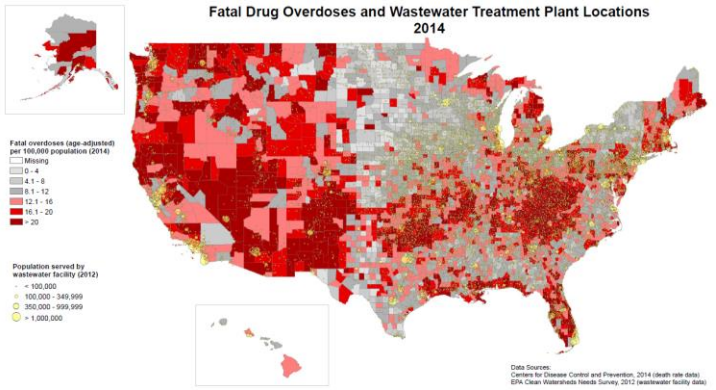
Massachusetts Counties



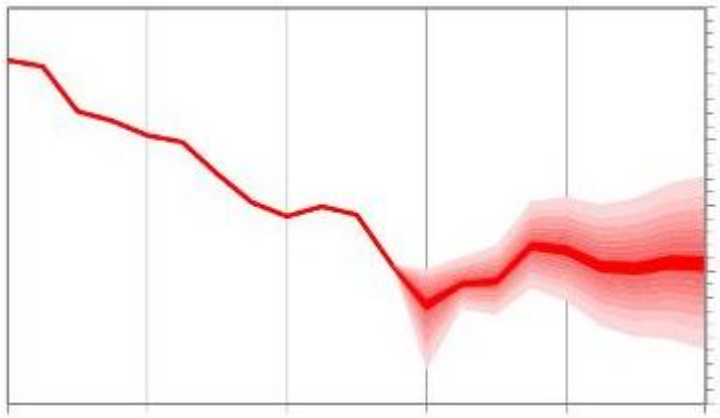
Analytic Components

Multidimensional

Spatial



Forecasting

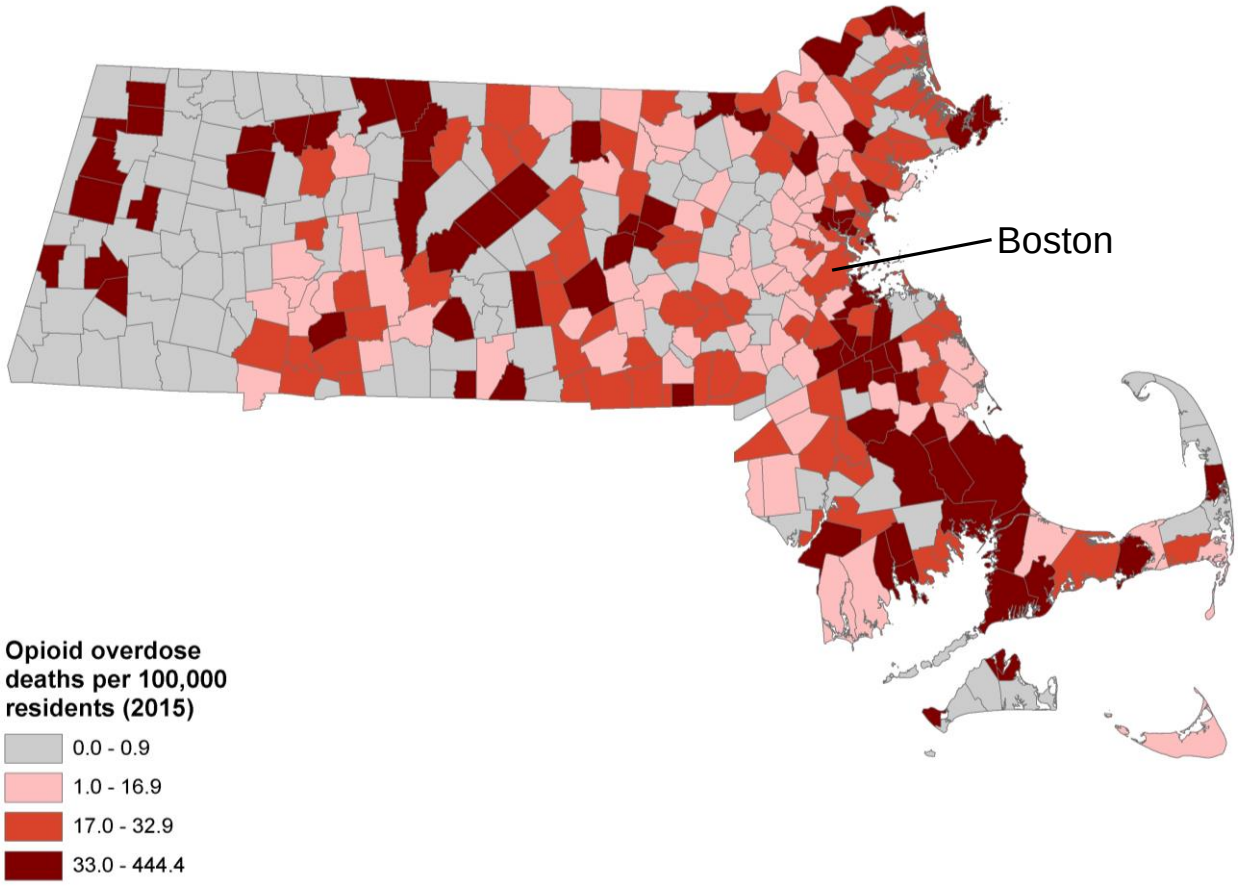


Machine Learning

Multidimensional

Domain	Source	Variables
Outcome	MA DPH	• Number of opioid overdose deaths (per 100,000 residents)
Demographics	MA State Data Center	• Population per city/town in MA
	2015 American Community Survey five-year estimates	• Median age • Percent male residents • Percent white residents • Percent uninsured • Percent unemployed • Median income • Percent disabled • Percent who have public health insurance
Prescriptions	MA Prescription Monitoring Program	• Number of opioid prescriptions • Percent of people with a class II opioid prescription • Percent of people with activity of concern (shop around)
Treatment for addiction	MA Bureau of Substance Abuse Services	• Percent of drug treatment admissions with opioids as the primary drug
Law enforcement	National Incident-Based Reporting System	• Number of drug-related offenses • Number of crimes against society
Spatial	MA Office of Geographic Information	• Latitude • Longitude

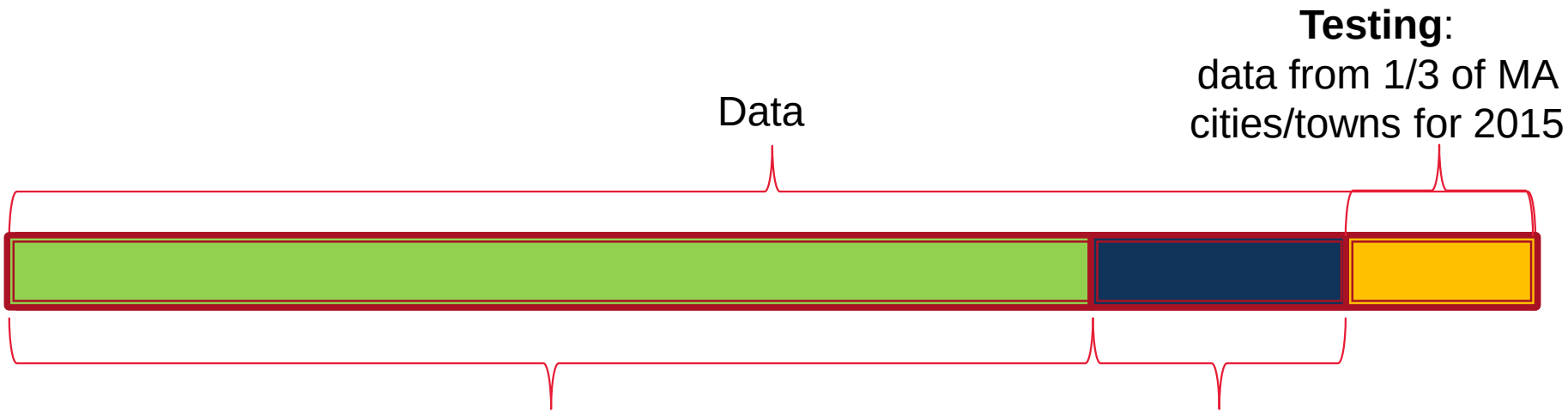
Spatial



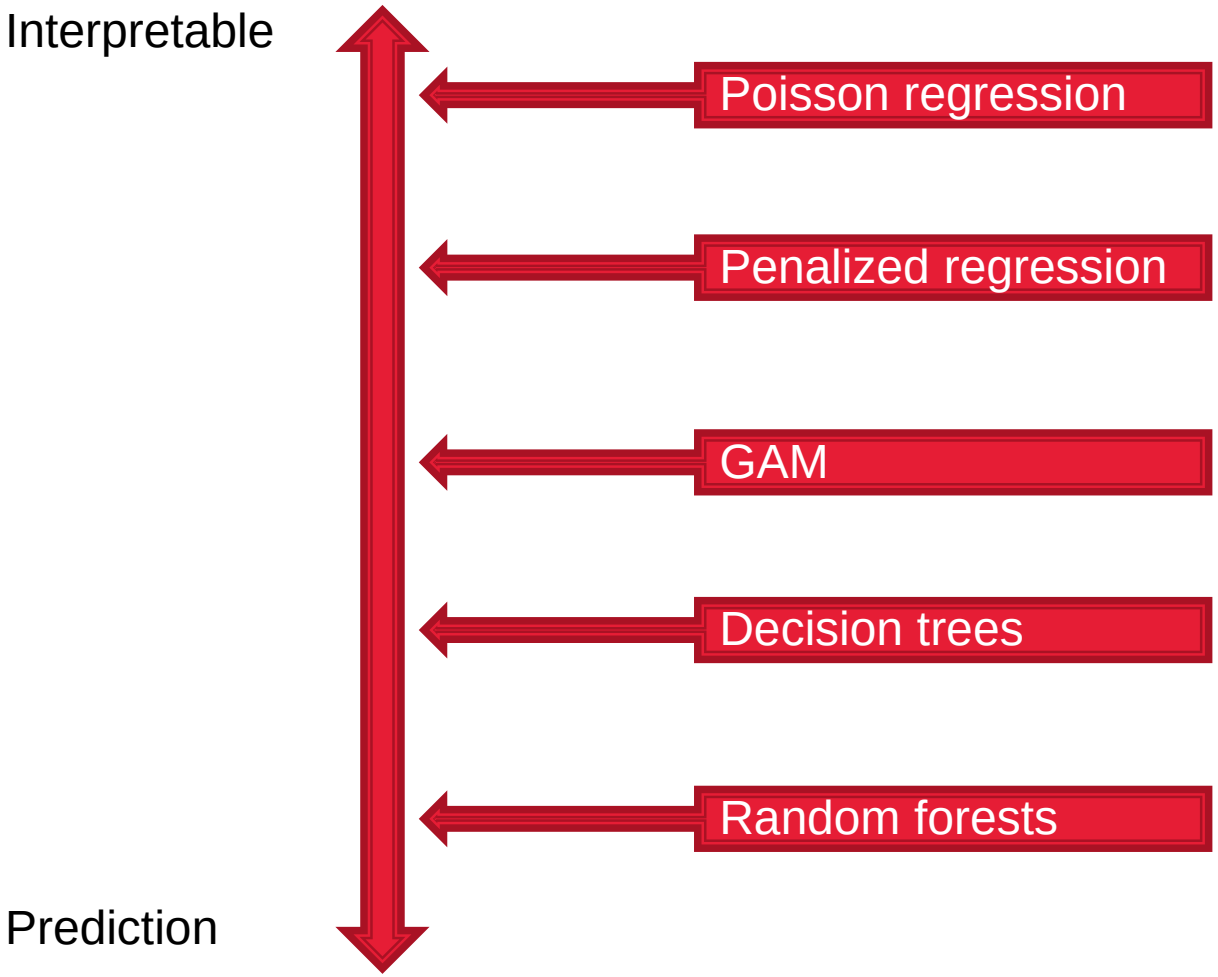
- Latitude and longitude
- Distance from Boston
- Average death rate in contiguous cities/towns

Predictive Analytics

In predictive analytics, it is critical to develop a framework that will enable an accurate assessment of the predictive power of the model; this assessment differs from traditional statistical methods because prediction aims to extrapolate results to a future population.



Machine Learning



A generalized linear model form of regression analysis used to model count data

A regression analysis method that performs regularization

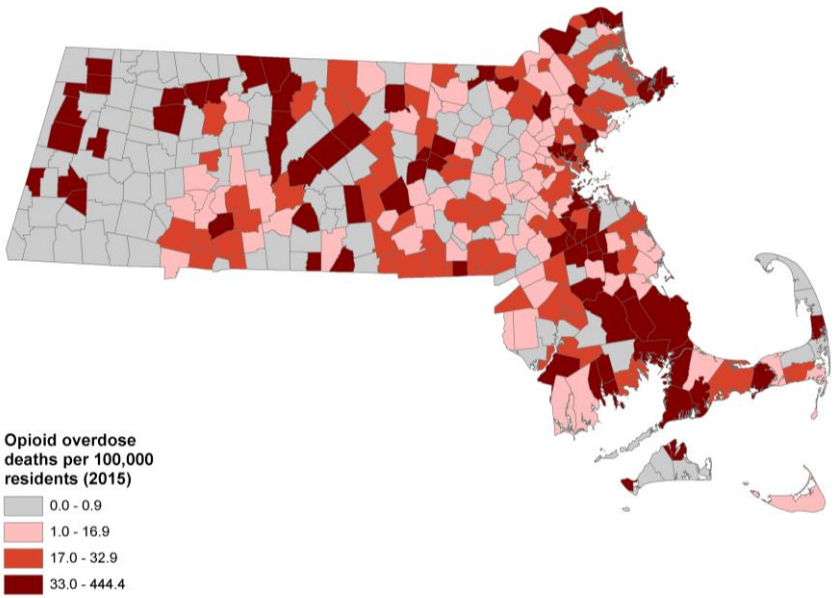
A generalized linear model in which the predictor depends linearly on unknown smooth functions of some predictor variables

A statistical method for multivariable analysis in which a decision tree is created to classify observations

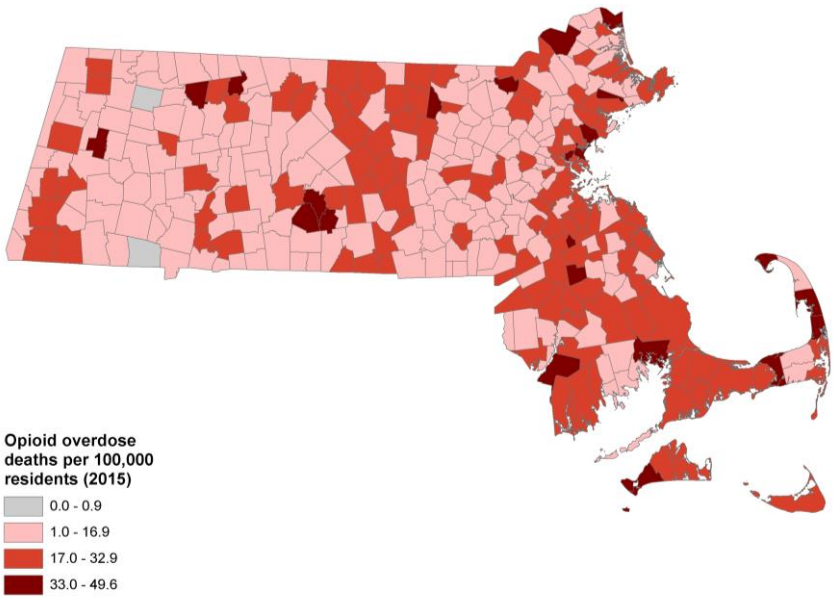
An ensemble learning method that constructs a multitude of decision trees and outputs the average prediction across the individual trees

Results (same scale)

Observed

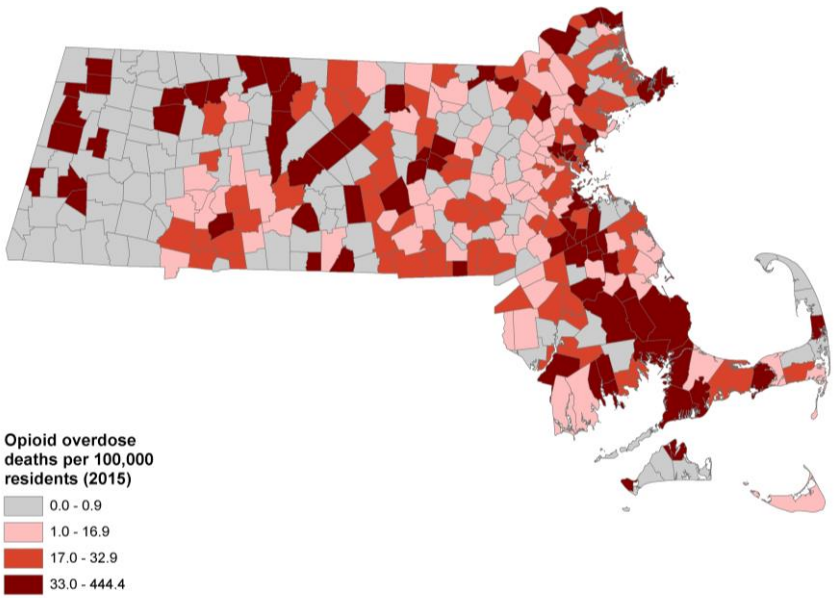


Predicted

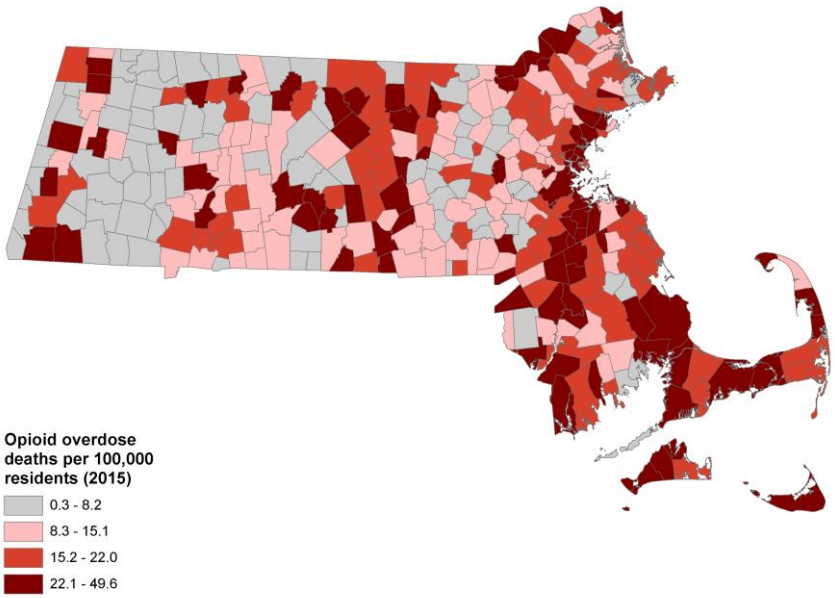


Results (data-specific scale)

Observed



Predicted



Findings

Aggregate-level predictions

- May have potential to predict broad ranking of a city/town based on overdose death rate (e.g., if death rate is among top 25% across MA)
- Most of the predictive power was derived from the opioid-related fatality rate of the previous year
- Aggregated statistics on demographics, prescriptions, treatment, and drug-related crimes was only weakly correlated with death rates
- Challenges arise for towns with small populations

Finding from MA DPH analysis

Individual-level associations

- People who died from opioid-related overdoses are much more likely to have an illegally obtained substance present in post-mortem toxicology
- People on opioid agonist treatments after a nonfatal overdose are significantly less likely to die
- Women are significantly more likely than men to receive opioids from 3+ prescribers and to fill them at 3+ pharmacies
- Risk of opioid overdose death after incarceration is 56x higher than for the general public

Discussion

- Value of wastewater on prediction
  - Real-time data
- Integrating wastewater data with existing data
  - Aggregate vs. individual-level analysis
  - Not always perfectly aligned with county or town borders

For More Information

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Panel Discussion

Ravi Goyal
Mathematica Policy Research

Jaya Tripathi
The MITRE Corporation

Scott Cody
Project Evident

MATHEMATICA
Policy Research

MITRE

Using Advanced Analytics to Identify and Reduce Prescription Drug Fraud and Abuse

Wastewater Symposium
Washington, DC

May 16, 2017

Jaya Tripathi
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Multi-pronged Approach to Mining your Data

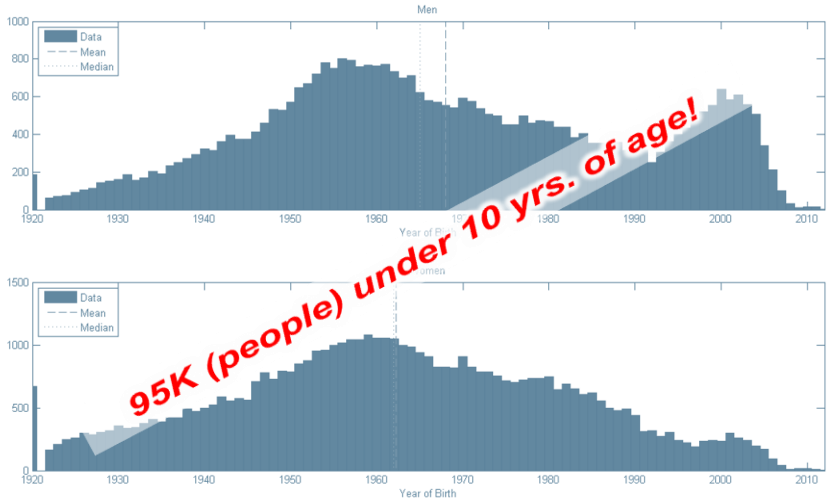
- **exploration**
  - histograms, PCA, t-SNE, clustering, visualizations, other statistical analyses
- **transformation**
  - timeline summaries, feature engineering
- **geo-spatial analytics**
  - ‘hot spots’, correlation studies using other datasets
- **graph analytics**
  - tripartite graphs, connectivity, entropy and motifs
- **machine learning**
  - predictive models, ‘ground truth’, validation

Results

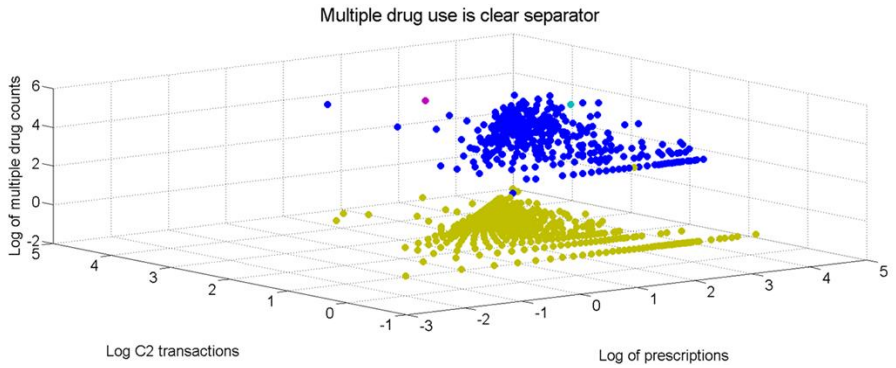
some examples of applications of the techniques …

Exploration

Age Gender Histogram



3D Scatter Plot

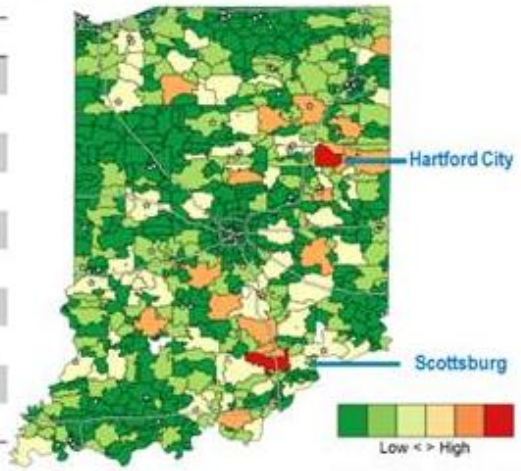


Geo-Spatial and Graph Analytics

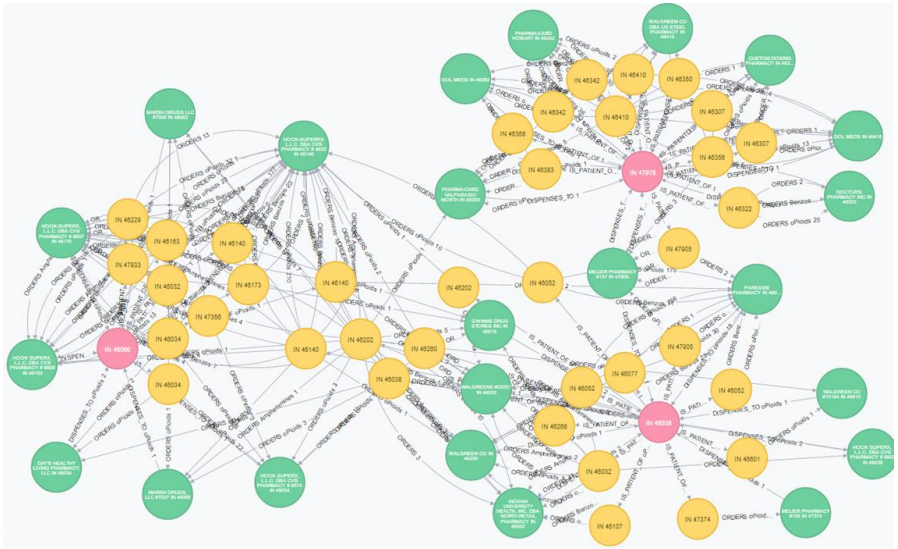
Heat Map

What areas of Indiana have the most patients oxymorphone?

Rank	ZCTA
1	47348
2	47170
3	47336
4	47102
5	47371
6	47112
7	46151
8	47359
9	46996
10	46721



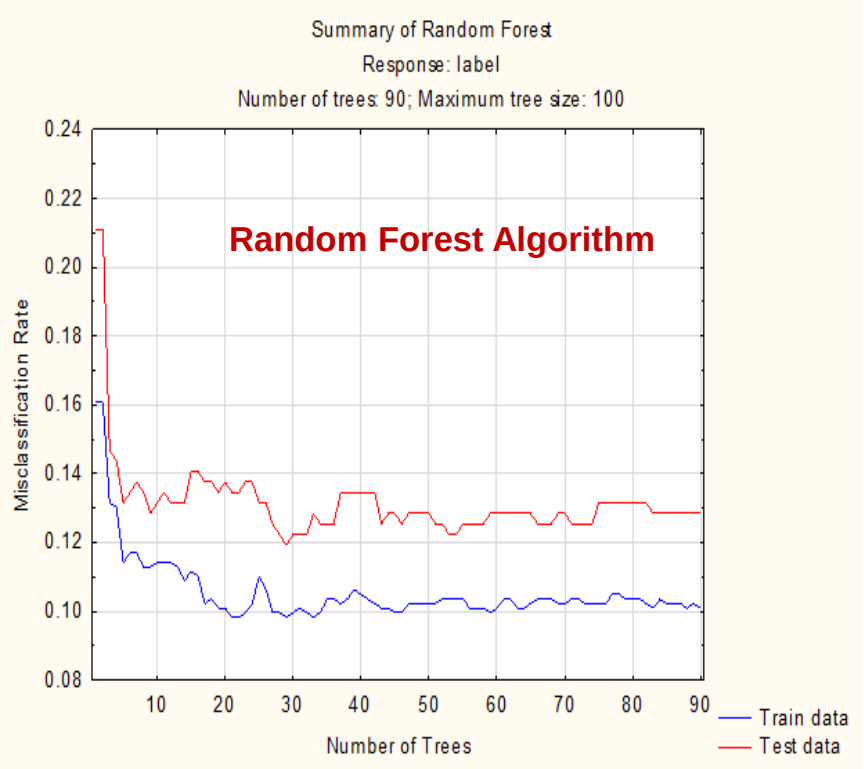
Doctor Shopping networks

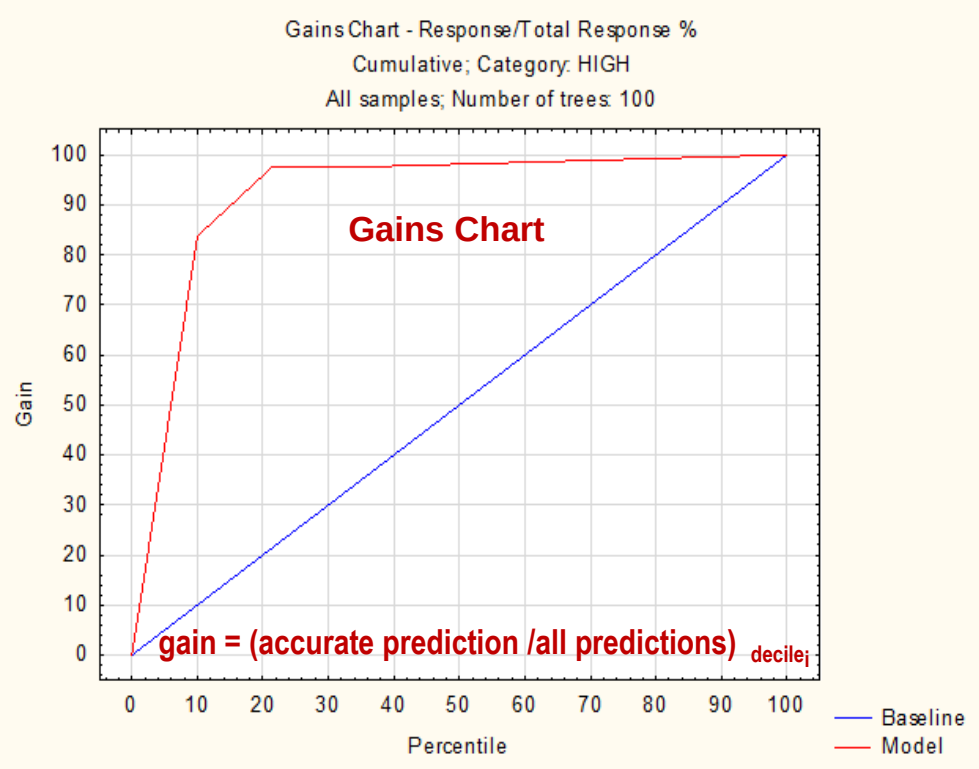


Risk Scoring with Classification Systems

Engaged human experts for 'ground truth'

Employed Supervised Machine Learning Models





IX. Steps to advance wastewater testing for decision making

Craig Thornton
Mathematica Policy Research

Jon Glaudemans
United Rheumatology

Audience Q&A

If given $100 to invest in any of the four critical pathways below, how much would you invest in each?

- **A) Testing methods**
- **B) Proof-of-concept pilot studies**
- **C) Data/metric integration**
- **D) Leadership and collaboration**

X. Closing remarks and synthesis

Aparna Keshaviah

Mathematica Policy Research

MATHEMATICA
Policy Research

Closing Remarks & Synthesis

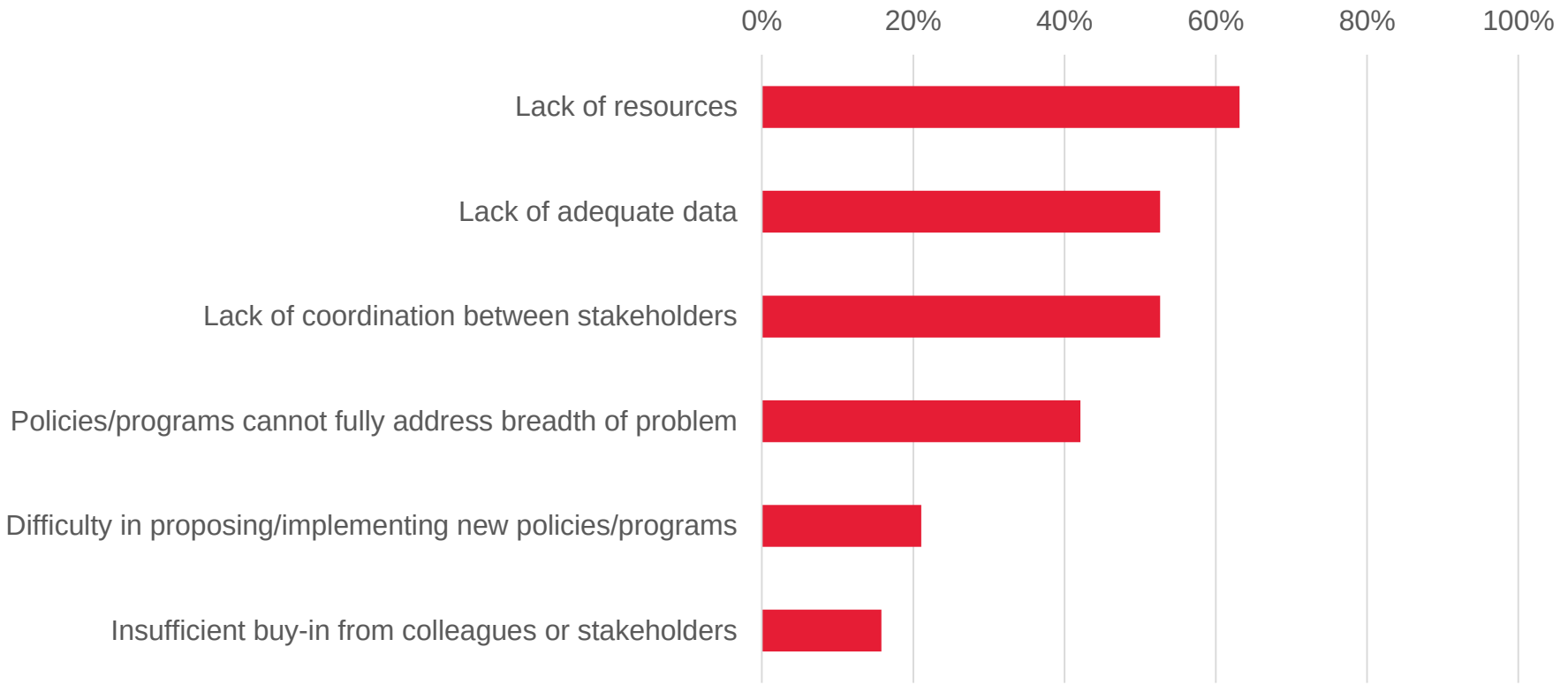
Wastewater Symposium
Washington, DC

May 16, 2017

Aparna Keshaviah, Sc.M.

Critical Needs (per participant survey)

*What are your top 3 critical needs or challenges in your day-to-day work addressing the opioid crisis and other substance abuse issues?**



**Based on 19 participants who answered this question in the participant survey*

Possible Futures

Short- and Mid-term

- **Cost-benefit analysis**
- **Pilot studies**
  - Applications
  - Participating communities
  - Funding sources
- **Collaborative research groups**

Long-term

- **Coordinating center (cross-agency)**
- **Standardized procedures (protocols, central testing labs, etc.)**
- **Data warehouse (multi-drug)**
- **Monitoring system (large-scale)**

- Special report forthcoming -

For more information

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